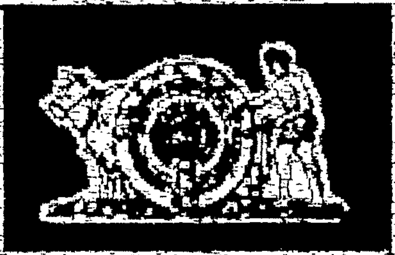
ISSN 0003-2950

The Andhra Agric. J. 49 (3&4) : 203 - 398, 2002



# THE ANDHRA AGRICULTURAL JOURNAL

THE ANDHRA AGRICULTURAL UNION
AGRICULTURAL COLLEGE, BAPATLA - 522 101 (AP) INDIA
ACHARYA N. G. RANGA AGRICULTURAL UNIVERSITY

# THE ANDHRA AGRICULTURAL UNION

### (Registered under Act XXI of 1880)

Journal started in 1954 as Bimonthly and converted to quarterly from 1982 onwards and registered with the Registrar of News Paper of India as quarterly under The Press and Registration of Books Act, 1867 with Registration No. 575/57.

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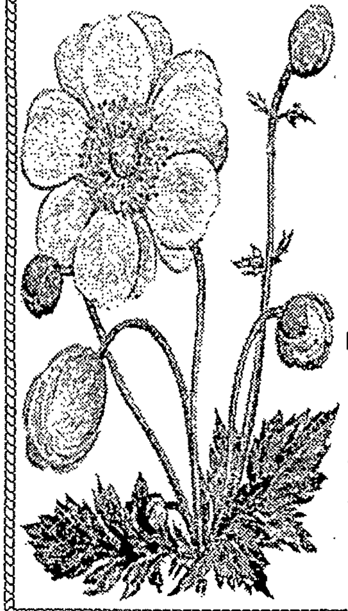

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# The Andhra Agricultural Journal

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# Effect of Nitrogen and Phosphorus Levels on Growth and yield of Maize (*Zea mays* L.) Under Rainfed Condition of Nagaland

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## ABSTRACT

The experiment was conducted on maize cv. 'Vijay' in *Kharif* season during 2000 at Experimental Farms of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema Campus. The experiment was conducted with 12 treatment combinations consisting of 4 levels of N (0, 50, 100 and 150 Kg) and 3 levels of P (0, 40 and 80 kg $ha^{-1}$) in a factorial RBD, replicated thrice. The results revealed that the increasing levels of nitrogen and phosphorus significantly increased the plant height, stem thickness, leaf area index (LAI), crop growth rate (CGR) and yield. However, increasing levels of nitrogen and phosphorus doses decreasd the Relative Growth Rate (RGR) at 60 and 90 days after sowing (DAS). Maximum growth attributes viz. plant height (84.67cm), stem thickness (1.85cm), LAI (3.82), CGR (11.12) were recorded at 90 DAS and yield (28.28 q/$ha^{-1}$) at harvest with N150 kg $ha^{-1}$. The RGR recorded at nitrogen level of 100 Kg and 150 kg $ha^{-1}$ were at par. The interaction between nitrogen and phosphorus level did not show any significant effect on stem thickness, CGR and yield, on the other hand significantly effects were observed on LAI at 90 DAS and plant height at 60 DAS.

**Key Words :** Maize, Growth, Yield, Nitrogen and Phosphorus.

Among cereals, maize being a $C_4$ plant capable of utilizing solar energy more efficiently. Maize has very high yield potential so called as 'queen of cereals'. Because of high yield potential maize crop require high amount of nutrients. For better crop production, nutrient supply plays very important role. If nutrient supply falls short of demands, it causes reduction in yield. Similarly, excessive would result in lower yield (Panchanathan *et.al.*, 1978).

The North East Region (NER) is one of the major growing belt covering an area of more than 13.2 thousand hectares with an average productivity of 1265 kg $ha^{-1}$. Maize is primarily grown in shifting cultivation in this region and covers 42 per cent of such area (Vinay *et.al.*, 1996). In Nagaland, maize is cultivated in an area of 31.5 thousand hectares with a total production of 34.9 thousand tonnes (Fertilizer Statistics, 1993 - 94). The main cause of low yield in North East Region is mainly due to poor fertility management under shifting, terrace, valley and plains area cultivation. Therefore the present investigation was undertaken to assess comparative efficiency of levels of nitrogen and phosphorus and their combination on growth and yield of maize under rainfed condition of Nagaland.

## MATERIAL AND METHODS

The experiment was undertaken at the experimental farms of School of Agricultural Sciences & Rural Development, Nagaland University, Medziphema Campus. The farm is located in the foothills of Nagaland at an altitude of 310 m with geographical location of 25°45'45" N latitude and 93°53'04" E longitude. The mean summer temperature ranges between 21°C to 32°C and in winter it rarely goes below 8°C with an average annual rainfall varying from 200 cm to 270 and falls in humid sub-tropical zone.

The soil of field was sandy loam in texture and acidic in reaction (pH 4.90). The organic carbon available nitrogen, available phosphorus and available potash content were 1.95%, 188 kg ha$^{-1}$, 21 kg ha$^{-1}$ 86 kg ha$^{-1}$ respectively. The experiment was laid out in Fractional Randomized Block Design with 3 replications. The plot size was 4m x 3m. There were 12 treatment combinations consisting 4 levels of Nitrogen (0, 50, 100 and 150 kg ha$^{-1}$), 3 levels of phosphorus (0, 40 and 80 kg ha$^{-1}$). FYM has applied @ 20t ha$^{-1}$ before 15 days of sowing in all plots. A common dose of potash (40 kg ha$^{-1}$) in the form of muriate of potash was applied. The nitrogen and phosphorus was applied through Urea and single super phosphate (SSP), respectively. Maize cv. 'Vijay' was sown with a spacing of 60cm x 25cm. The observations were taken at 30 days intervals for growth attributes.

## RESULTS AND DISCUSSION

**Growth Attributes:** The results (Table 1) reveal that all the levels of nitrogen and Phosphorus had conspicuous influence on height of plant recorded at 30, 60, 90 DAS and at maturity. The increasing levels of Nitrogen and Phosphorus was significantly incerased the plant height. The maximum plant height (84.76 cm) at 90 DAS was recorded with highest level of nitrogen ($N_{150}$). The effect of interaction between different levels of nitrogen and phosphorus was found non - significant at all the observations (Table -2). This result was in concordance with the findings of Srivastava and Sharma (1975).

The increasing levels of nitrogen and phosphorus application significantly increased the stem thickness at all the observations . The maximum stem thickness (1.85 cm) was observed at 90 DAS with the application of 150 kg ha$^{-1}$ (Table 1). It might be due to full utilization of available resources. The finding was in the agreement of Kwon *et al.*, (1988). Interaction between different levels of nitrogen and phosphorus did to show any significant difference on stem thickness. Increasing levels of nitrogen and phosphorus significantly increased the LAI at 30, 60 and 90 DAS. The effect of interaction between different level of nitrogen and phosphorus was failed to reach the significant level at 30 and 60 DAS. But it had significant influence on LAI at 90 DAS. The highest LAI (3.82) was recorded with the highest level of nitrogen ($N_{150}$) and phosphorus ($P_{80}$) combination. Leaf area index (LAI) shows synergistic effect of different doses of nitrogen. The result was in agreement with the findings of Srivastava *et.al.*, (1975). Bangarwa *et al.*, (1988) also reported that increasing nitrogen doses increased the LAI of maize.

The influence of nitrogen, phosphorus and their interaction on CGR was recorded the highest (11.12) with the highest level of nitrogen ($N_{150}$) at 60 DAS which was at par with $N_{100}$ at 60 DAS (Table 1 & 2). At 90 DAS the increasing doses of nitrogen decreases the CGR. The CGR was significantly increased with increasing doses of phosphorus at 30 and 90 DAS. At 90 DAS, CGR recorded with $P_{40}$ and $P_{80}$ was at par with each other. Phosphorus levels failed to reach the significant effect at 60 DAS. The effect of interaction between different levels of nitrogen and phosphorus did not show any significant difference on CGR at all the observations.

Crop growth rate (CGR) significantly increased with increasing levels of nitrogen at 30 and 60 DAS. However, at 90 DAS, CGR was decreased with increasing levels of nitrogen. It might be due to the plant attains the maturity stage at 90

Table 1: Effect of Nitrogen and Phosphorus levels on growth attributes and yield of maize

| Treatment | Plant height (cm) | | | Stem thickness (cm) | | | Leaf area index | | | Crop growth rate | | | Relative growth rate | | Yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 | 60 | 90 | 30 | 60 | 90 | 30 | 60 | 90 | 30 | 60 | 90 | 60 | 90 | ($qha^{-1}$) |
| Nitrogen | | | | | | | | | | | | | | | |
| $N_0$ | 66.06 | 186.22 | 212.97 | 1.48 | 1.61 | 1.63 | 0.51 | 2.46 | 3.07 | 1.68 | 6.54 | 5.92 | 0.69 | 0.0080 | 19.18 |
| $N_{50}$ | 73.71 | 194.07 | 220.45 | 1.55 | 1.72 | 1.75 | 0.56 | 2.56 | 3.30 | 2.48 | 8.00 | 5.57 | 0.63 | 0.0060 | 24.27 |
| $N_{100}$ | 80.62 | 205.81 | 232.22 | 1.76 | 1.74 | 1.79 | 0.63 | 2.69 | 3.56 | 3.86 | 10.75 | 2.88 | 0.58 | 0.0025 | 27.63 |
| $N_{150}$ | 84.67 | 215.63 | 241.23 | 1.79 | 1.81 | 1.85 | 0.73 | 2.87 | 3.74 | 4.72 | 11.12 | 2.74 | 0.52 | 0.0023 | 28.28 |
| CD (P=0.05) | 2.20 | 2.30 | 2.34 | 0.12 | 0.15 | 0.019 | 0.02 | 0.053 | 0.075 | 0.27 | 0.157 | 0.70 | 0.065 | 0.057 | 0.69 |
| Phosphorus | | | | | | | | | | | | | | | |
| $P_0$ | 72.35 | 193.95 | 220.22 | 1.55 | 1.65 | 1.67 | 0.59 | 2.61 | 3.34 | 2.85 | 8.91 | 3.01 | 0.64 | 0.0039 | 21.29 |
| $P_{40}$ | 75.93 | 201.24 | 227.30 | 1.65 | 1.73 | 1.77 | 0.61 | 2.64 | 3.39 | 3.21 | 8.94 | 4.83 | 0.60 | 0.0054 | 25.72 |
| $P_{80}$ | 80.52 | 206.12 | 232.63 | 1.74 | 1.78 | 1.82 | 0.63 | 2.69 | 3.52 | 3.49 | 9.43 | 5.06 | 0.58 | 0.0050 | 27.51 |
| CD (P=0.05) | 1.90 | 2.00 | 2.03 | 0.10 | 0.13 | 0.017 | 0.0005 | 0.046 | 0.065 | 0.12 | NS | 1.47 | 0.057 | 0.0180 | 0.060 |

Table 2: Interaction effect of Nitrogen and Phosphorus levels on growth attributes and yield of maize

| Treatment | Plant height (cm) | | | Stem thickness (cm) | | | Leaf area index | | | Crop growth rate | | | Relative growth rate | | Yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 | 60 | 90 | 30 | 60 | 90 | 30 | 60 | 90 | 30 | 60 | 90 | 30 | 60 | ($qha^{-1}$) |
| $N_0P_0$ | 63.60 | 183.27 | 208.64 | 1.38 | 0.52 | 1.53 | 0.50 | 2.44 | 2.98 | 1.52 | 5.91 | 4.28 | 0.68 | 0.0073 | 16.58 |
| $N_0P_{40}$ | 64.06 | 186.27 | 213.26 | 1.48 | 1.61 | 1.64 | 0.51 | 2.46 | 3.09 | 1.63 | 5.94 | 6.87 | 0.68 | 0.0090 | 19.77 |
| $N_0P_{80}$ | 70.53 | 189.13 | 217.00 | 1.56 | 1.70 | 1.72 | 0.53 | 2.49 | 3.14 | 1.89 | 7.76 | 6.64 | 0.71 | 0.0080 | 21.20 |
| $N_{50}P_0$ | 69.13 | 188.43 | 214.07 | 1.50 | 1.70 | 1.65 | 0.53 | 2.53 | 3.18 | 2.11 | 7.92 | 4.34 | 0.68 | 0.0050 | 20.80 |
| $N_{50}P_{40}$ | 72.67 | 194.47 | 220.70 | 1.58 | 1.74 | 1.78 | 0.57 | 2.56 | 3.19 | 2.45 | 8.65 | 5.93 | 0.66 | 0.0060 | 24.80 |
| $N_{50}P_{80}$ | 79.33 | 199.33 | 226.60 | 1.57 | 1.78 | 1.81 | 0.58 | 2.60 | 3.54 | 2.89 | 7.44 | 6.44 | 0.55 | 0.0070 | 27.20 |
| $N_{100}P_0$ | 76.00 | 195.62 | 224.20 | 1.67 | 1.68 | 1.73 | 0.61 | 2.67 | 3.53 | 3.33 | 10.70 | 1.35 | 0.63 | 0.0023 | 23.60 |
| $N_{100}P_{40}$ | 81.00 | 208.07 | 232.67 | 1.69 | 1.75 | 1.80 | 0.64 | 2.68 | 3.56 | 4.00 | 10.91 | 2.21 | 0.57 | 0.0020 | 28.60 |
| $N_{100}P_{80}$ | 84.87 | 213.73 | 239.80 | 1.91 | 1.79 | 1.85 | 0.65 | 2.73 | 3.59 | 4.28 | 10.65 | 4.08 | 0.55 | 0.0033 | 30.70 |
| $N_{150}P_0$ | 80.67 | 208.47 | 234.60 | 1.63 | 1.74 | 1.79 | 0.72 | 2.81 | 3.67 | 4.44 | 11.12 | 0.82 | 0.55 | 0.0008 | 24.20 |
| $N_{150}P_{40}$ | 86.00 | 216.15 | 242.59 | 1.83 | 1.83 | 1.86 | 0.73 | 2.85 | 3.73 | 4.78 | 10.28 | 4.31 | 0.50 | 0.0040 | 29.70 |
| $N_{150}P_{80}$ | 87.33 | 222.28 | 247.12 | 1.93 | 1.85 | 1.91 | 0.75 | 2.95 | 3.82 | 4.93 | 11.87 | 3.09 | 0.53 | 0.0023 | 30.93 |
| CD (P=0.05) | NS | 3.99 | NS | NS | NS | NS | NS | NS | 0.13 | NS | NS | NS | NS | NS | NS |

DAS. The CGR was ceased between 90 DAS and at maturity, which may be due to maximum saturation of nutrients. The CGR values at 60 and 90 DAS were at par with $N_{100}$ and $N_{150}$. Similar observations were also made by Bangarwa *et al.*, (1993).

The RGR recorded at $N_{100}$ and $N_{150}$ were 0.023 and 0.0215 respectively which were at par. It might be due to the increasing levels of nutrient concentration into the plants. RGR was almost constant between 90 DAS and at maturity. Kang *et al.*, (1989) reported that increasing nitrogen rates increased the LAI, CGR and RGR when applied nitrogen @ 150 kg $ha^{-1}$.

**Yield :** The result presented in Tables 1 & 2 indicated that application of different level of nitrogen and Phosphorus significantly increased the grain yield. The grain yield recorded at $N_0$, $N_{50}$, $N_{100}$, $N_{150}$ were 19.18, 24.27, 27.23 and 28.28 q $ha^{-1}$ respectively. The grain yield recorded at $N_{100}$ and $N_{150}$ were at par. The highest grain yield was found with the combination of $N_{150}$ and $P_{80}$. This finding is in accordance with Lutz and Jone (1971), who stated that increasing level of phosphorus significantly increased the grain yield. This finding was also in support of the findings of Sharma *et al.*, (2000). Interaction between nitrogen and phosphorus did not have profound effect on grain yield.

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(Received on 31-12-2001 and revised on 9-8-2002 )

The Andhra Agric. J. 49 (3&4) : 207-210, 2002

# Variability and Genetic Parameters for Yield and Yield Components in Aromatic Rice

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## ABSTRACT

Variability and heritability parameters were estimated for 9 yield and yield related traits in 10 parents (8 aromatic and 2 non-scented) and their 25 hybrids during *Kharif* 1999. All the characters manifested low to moderate estimates of variability, genetic advance accompanied with moderate to high heritability except number of tillers in parents and number of filled grains per panicle in hybrids, suggesting the preponderance of both additive and non-additive gene actions in the expression of these traits. Number of tillers in parents and fertile grains/panicle in hybrids might be conditioned by non-additive and additive gene effects respectively. Hence both of these genetic components could be exploited effectively by practicing reciprocal recurrent selection.

**Key Words** : Variability; Genetic Parameters; Components; Aromatic

Improvement of yield through direct selection may not be of much use as this character is highly influenced by environment. Knowledge on the nature and magnitude of genotypic and phenotypic variability, present in any crop species, plays a vital role in successful selection for evolving superior cultivars. The magnitude of heritable variation in breeding material, more particularly its genetic component has immense value in the fixation of particular traits. Genetic advance refers to the improvement in the mean genotypic value of selected families over population, high genetic advance along with high heritability indicates that improvement could be made for such character by simple selection on phenotypic performance. The present study is aimed to estimate the variability and genetic parameters for yield and yield components in aromatic rice.

## MATERIAL AND METHODS

IR 64, PR 109, Gaurav, IR 62874-88-2-1 and PK 1379-9-1-1 (used as lines) were crossed with 5 basmati testers *viz.*, HBC 85, Karnal Local, Basmati 410, Basmati 6129 and PGB in a line x tester fashion to obtain 25 hybrids. All these 35 genotypes (10 parents and 25 hybrids) along with a standard check Pusa Basmati 1 were evaluated in a Randomized Block Design with 2 replications at DRR farm, Hyderabad. Standard cultural practices and need based plant protection measures were undertaken. Observations were taken on 10 randomly selected plants per replication for 9 yield and yield components *viz.*, plant height, number of tillers, panicle length, filled grains/ panicle, sterile grains / panicle, total spikelets / panicle, sterility percentage, test weight and grain yield / plant. Standard procedures were followed for taking observations and the sterility percentage was calculated as the percentage ratio of total chaffy grains per panicle to total number of spikelets per panicle. The mean data was used for calculating the phenotypic and genotypic coefficient of variation using the formulae given by Burton and Devane (1952), heritability and genetic advance were estimated as per Allard (1960).

## RESULTS AND DISCUSSION

The analysis of variance results exhibited significant differences for all the characters studied except for number of tillers in parents indicating the presence of wide variability in the material under study (Table 1). The mean plant height in hybrids (98.80 cm) was lower than the parents (108.20 cm) (Table 2), while number of tillers and panicle length recorded higher mean value in hybrids than the parents which is desirable. Even though, the mean value for fertile grains / panicle in hybrids was low, they manifested higher number of total spikelets / panicle than the parents indicating that hybrids had more sterile grains / panicle when compared to parents. Finally, the hybrids manifested higher test weight and grain yield per plant than the parents. In general, the phenotypic coefficient of variation was higher than the genotypic coefficient of variation, but the difference was low indicating the meagre environmental influence on the expression of these traits. Plant height and panicle length recorded higher values in parents for both phenotypic and genotypic coefficient of variation than in hybrids indicating wide variation in parents for these traits. For the remaining traits *viz.*, fertile grains/panicle, sterile grains / panicle, total spikelets / panicle, sterility percentage and grain yield per plant, hybrids recorded more variability both at phenotypic and genotypic level. The genotypic coefficient of variation ranged from 2.27 (number of tillers in parents) to 82.52 (fertile grains / panicle in hybrids). With the exception of number of tillers, in parents all other characters recorded moderately high to very high heritability estimates with a range of 68.99% (panicle length) to 99.72% (plant height). Hybrids manifested moderately high to high estimates of heritability for all the characters studied which ranged from 54.29% (panicle length) to 99.17 (grain yield / plant).

In general, parents recorded low to moderate genetic advance, with a range of 0.191 (test weight) to 26.91 (fertile grains / panicle). In hybrids, test weight, panicle length, number of tillers and plant height manifested low genetic advance per cent over mean while the remaining traits recorded moderate to high estimates for genetic advance. In parents, all the characters manifested low to moderate variability, moderately high to very high heritability accompanied with low to moderate genetic advance per cent over mean except number of tillers, suggesting the influence of both additive and non - additive gene effects in the expression of these traits. It seems that non-additive gene action might be playing an important role in conditioning number of tillers among parents, as this trait recorded very low estimates for all the genetic parameters studied. Among hybrids, all the characters except fertile grains/panicle manifested low to moderate coefficients of variation, moderate to high heritability and low to moderate expected genetic advance per cent over mean indicating the preponderance of both additive and non-additive gene effects in controlling these traits. High heritability coupled with low genetic advance for plant height was reported by Dhanraj (1987) and for tillers by Ravindra Nath *et al* (1983), moderate heritability coupled with low genetic advance for panicle length was earlier reported by Sharma and

Table 1: Analysis of variance for yield and yield components.

| Source | D.f | Plant height | No. of tillers | Pancle length | Fertile grains/ panicle | Sterile grains/ panicle | Total spikelets/ panicle | Sterility percentage | Grain yield per plant | Test weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Replications | 1 | 1.72 | 0.56 | 3.36 | 2.33 | 3.09 | 0.001 | 20.81 | 0.19 | 0.04 |
| Genotypes | 35 | 284.40** | 107.86** | 3.69** | 2868.62** | 2055.71** | 1304.31** | 1723.03** | 211.11** | 0.03** |
| Parents | 9 | 766.86** | 0.87 | 4.05** | 376.85** | 88.84** | 301.88** | 102.59** | 9.99** | 0.02** |
| Crosses | 24 | 74.54** | 14.78** | 1.71** | 2978.73** | 1729.93** | 1723.62** | 1352.23** | 285.59** | 0.02** |
| Parents vs Crosses | 1 | 1256.04** | 3246.67** | 43.99** | 18925.51** | 26988.34** | 715.46** | 24110.13** | 442.04** | 0.27** |
| Error | 35 | 0.93 | 1.21 | 0.59 | 7.51 | 6.93 | 10.21 | 2.31 | 1.01 | 0.002 |

** : Significant at 0.01% level

Table 2: Genetic parameters for 9 yield and yield components in 10 parents used in the crossing programme and their 25 hybrids

| Character | Mean (ξ) | | Phenotypic coefficient of Variation | | Genotypic coefficient of Variation | | Heritability (%) | | Genetic advance | | Genetic gain / cent over mean | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Parents | Hybrids | Parents | Hybrids | Parents | Hybrids | Parents | Hybrids | Parents | Hybrids | Parents | Hybrids |
| Plant height (cm) | 108.20 | 98.80 | 18.11 | 6.21 | 18.09 | 6.14 | 99.72 | 97.64 | 4.25 | 12.35 | 3.93 | 12.5 |
| Number of tillers | 14.02 | 29.09 | 6.24 | 9.79 | 2.27 | 8.87 | 13.20 | 81.90 | 0.24 | 4.81 | 1.77 | 16.54 |
| Panicle length (cm) | 23.27 | 25.02 | 6.65 | 4.21 | 5.53 | 3.10 | 68.99 | 54.29 | 2.20 | 1.18 | 9.45 | 4.72 |
| Fertile grains/panicle | 83.11 | 46.71 | 16.78 | 82.70 | 16.25 | 82.52 | 93.73 | 99.59 | 29.91 | 79.24 | 32.37 | 169.64 |
| Sterile grains/panicle | 20.93 | 64.39 | 32.51 | 45.78 | 31.18 | 45.57 | 92.00 | 99.05 | 12.89 | 60.15 | 61.59 | 93.42 |
| Total spikelets/panicle | 103.97 | 111.05 | 11.96 | 26.52 | 11.67 | 26.35 | 95.26 | 98.72 | 24.39 | 59.89 | 23.46 | 53.93 |
| Sterility percentage | 20.56 | 61.64 | 35.39 | 42.22 | 34.29 | 42.15 | 93.93 | 99.68 | 14.07 | 53.44 | 68.43 | 86.70 |
| Test weight (g) | 1.92 | 2.14 | 5.33 | 5.45 | 5.16 | 5.07 | 93.60 | 86.76 | 0.191 | 0.20 | 10.05 | 9.35 |
| Grain yield/plant(g) | 11.1 | 16.66 | 20.62 | 71.88 | 19.65 | 71.58 | 90.85 | 99.17 | 4.28 | 24.46 | 38.56 | 146.82 |

Dubey (1997) which is in confirmation with the results of present investigation. Mishra *et al* (1996) observed high heritability accompanied with low genetic advance for grain yield, test weight and spikelet sterility which are in accordance with the present results. In hybrids, the character fertile grains / panicle registered higher estimates for all the genetic parameters studied indicating that these traits might be conditioned by additive gene effects. Ganeshan *et al* (1996) also observed same results for filled grains / panicle which suggests this trait might be improved by simple selection. Finally in both parents and hybrids, most of the characters studied showed the influence of both additive and non-additive gene actions in their expression. Hence it is suggested to follow recurrent selection or reciprocal recurrent selection to exploit both additive and non-additive genetic components.

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(Received on 28-1-2002 and revised on 7-8-2002)

The Andhra Agric. J. 49 (3&4) : 211-218, 2002

# Influence of Pre-sowing Seed Treatment on Speed of Germination (Seed Vigour) Flowering and yield in Marigold at Different Planting Dates

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## ABSTRACT

The effectiveness of pre - sowing seed treatments on germination, speed of germination (Seed vigour), field establishment, flowering and yield of *Tagetes erecta L and Tagetes patula L* were studied for their possible inclusion in the crop production strategy. Water soaking for 24 hrs. before sowing was found to be the best treatment. Seeds soaked or immersed in distilled water at 25ºC for 24 hrs germinated earlier by 2-3 days in African marigold and 1-2 days in French marigold compared to dry seed sowing (control). Significant differences between the treatments were evident. Sowing of pre-soaked seeds resulted in higher germination and vigour, rapid and uniform seedling emergence and better seedling establishment, early flowering and higher yields. Storage of hydrated, dried seeds at 15ºC for 6 months resulted in reduced total germination and the potential capacity for rapid germination.

**Key Words :** Germination, Flowering, Marigold, Planting Dates

Marigold is one of the most popular annual flower crop grown all over India for various commercial purposes such as loose flowers, extraction of carotenoid pigments, essential oil and dry flower making apart from its traditional uses as a garden plant, nematode-repellent as well as a trap crop in integrated pest management programmes of agricultural crops. Industrial uses of carotenoids include pharmaceuticals, food supplements, animal feed additives and colourants in cosmetics. In recent years both area and production of loose flowers has increased substantially and the crop is grown in an area of about 17,700 hectares in different states of the country producing nearly 1.6 lakh tonnes of fresh flowers. In most parts of the country, small and marginal farmers grow marigolds in small areas and it goes uncounted for when the statistics are compiled. Hence, the actual area under this crop is likely to be much higher . According to Ar. Sukumar (2000), Andhra Pradesh stands first with the highest area of 4500 ha under its cultivation producing 30,000 metric tonnes of fresh flowers (52.2% of traditional flowers).

Marigold is mostly sown in October / November months. But the demand for loose flowers peaks up around festival times, particularly in October - November. The xanthophyl pigment (carotenoid pigment) and essential oil extraction units have the year round requirement where as dry flower industry needs flowers mostly in dry season of the year.

Priming (in which seeds imbibe sufficient water to begin the process of germination to a pre-determined point) seeds in osmotic solutions of polyethylene glycol (PEG) 8000 of $K_3PO_4$ and $KNO_3$ salts as Osmotica improved the germination of Impatiens (*Impatiens Wallerana Hook*) (Simmonds, 1980), lettuce (*Lactuca Sativa* L.) (Cantliffe, 1981), Salvia (Carpenter, 1989) and tomato (*Lycopersicon esculentum*) (Rumpel and Szudyga, 1978) at excessively high temperatures. No recommendations have been reported for priming marigold seeds so far.

In the present study, the sowing of marigold seeds was advanced to explore the possibility of producing flowers to coincide with the seasonal demands. Simple seed treatments were given to see their possible use in improving the rapid and uniform germination, seedling emergence and establishment, flowering and yield in off-season sowings under different dates of sowing.

## MATERIAL AND METHODS

Field experiment was conducted at The Division of Floriculture and Landscaping, IARI, New Delhi, during 1998 - 99 season in split plot design with planting dates as main treatments and seed treatments as sub treatments with three replications. African and French marigold (*Tagetes erecta* L and *T. Patula* L) respectively cvs., Pusa Narangi Gainda (which was developed at IARI, New Delhi) and Delhi local mix respectively were sown at monthly intervals starting from June to November 1998 (20th of every month) and were transplanted on 20th July, 20th August, 20th Sept, 24th October, 26th November and on 20th January, 1999 respectively. Due to heavy rains during June and July, we lost data on plants in control treatment and as a consequence the data of the remaining treatments was subjected to statistical analysis following Panse and Sukhatme, (1985) and the mean data of 4 dates of sowing treatments were presented in Tables 1 & 2.

In the experiment, four seed treatments given before sowing were ($T_1$) soaking of marigold seeds in distilled water for 24 hours; ($T_2$) seed soaking in 0.1 m M $KNO_3$ (prepared by dissolving 10 mg of Potassium nitrate in 100 ml of distilled water) for 24 hrs and ($T_3$) seed soaking in 0.1 m M $Na_2HPO_4$ (prepared by dissolving Disodium Hydrogen Phosphate ($Na_2HPO_4$), 0.0142g in 100 ml distilled water) for 24 hrs. and ($T_4$) dry seed sowing (control). The treated seeds were sown in the nursery as per the seed treatment.

Seedlings were transplanted in experimental field at a spacing of 45cm x 30 cm (plot size 3m x 2m) with recommended fertilizer dose (120 : 60 : 90 kg NPK $ha^{-1}$) as irrigated crop during 1998 - 99. Data was collected on germination %, speed of germination, field establishment, days to first flowering, 50% flowering, duration of flowering, flower diameter, flower yield $ha^{-1}$ and seed yield $ha^{-1}$. The details of the procedures followed are given here under.

**Germination Test :** 200 Nos. (50 each in petriplate) of seeds per replication (three replications were maintained) were kept for germination (ISTA, 1985) at 25°C in BOD. At 6th and 9th day, observations were recorded on % of germination under laboratory conditions.

**Seedling Emergence and Speed of Germination (Seed Vigour):** Three replicates of hundred seeds of both the varieties as per the treatments were hand - planted in soil in a completely randomized design. Any seedling, which has an intact plumule above the soil surface was considered to have emerged. The emergence of such seedlings in two cultivars was recorded from day one to ninth day. This germination count on ninth day was taken as final count for germination under open field conditions. Observations on the seedling emergence was recorded up to the ninth day and this data was used for calculation of speed of germination (seed vigour) as suggested by Maguire (1962).

$$\text{Speed of Germination (Seed Vigour)} = \Sigma \frac{n(d_1-d_2)}{t}$$

Where, n= number of seedlings emerged after days $d_1$-$d_9$. t = time in days

**Field Establishment :** Vigorously growing seedlings @ fourty four seedlings per plot were transplanted in the field. Number of plants survived per plot was recorded after 10th day of transplanting for calculating the per cent of field establishment.

$$\text{Field establishment \%} = \frac{\text{No. of Plants per plot survived after day 10} \times 100}{\text{Total No. of plants per plot transplanted (44)}}$$

The number of days taken transplanting to first flower opening in each plot was noted as days to first flowering. The number of days taken from seedling transplanting for half of the plant population showing opened flowers in each plot was noted as 50% flowering. Flower diameter was measured at fully opened stage with the help of scale by taking observations from North - South and East - West directions.

**Flower yield per hectare (tonnes) :** It was calculated by multiplying the percent field establishment with flower yield per plant with plant population.

$$\text{Flower Yield ha}^{-1}\text{ (tonnes)} = \frac{\text{Field establishment \%}}{100} \text{ X } \frac{\text{Flower yield in kg plant}^{-1} \text{ x Total area}}{\text{100 x Area occupied by single plant}}$$

$$\text{Seed yieldha}^{-1}\text{ (kg)} = \frac{\text{Field establishment \%}}{100} \text{ X } \frac{\text{Seed yield plant}^{-1} \text{ x Total area}}{\text{100 x Area occupied by single plant}}$$

**Storing Hydrated Seed :** A Study was conducted to determine the duration of benefits from primed marigold seed. The seeds were soaked for 4 hours in distilled water, dried in shade over silicagel in a desiccator and stored for six months. The seeds were tested for germination at bi-monthly interval and the stored seeds were hydrated for 24 hrs, before testing for germination. Both stored and rehydrated seeds were tested for standard germination.

## RESULTS AND DISCUSSION

Soaked seeds germinated sooner than dry seeds in both the cultivars under laboratory as well as open field conditions. Seeds sown dry had 73%±1 and 26% germination under lab and soil conditions respectively ($T_4$) where as other three treatments had significantly higher germination (Table 1). Seeds soaked in distilled water for 24 hrs ($T_1$), seeds soaked in 0.1m M $KNO_3$ for 24 hrs ($T_2$) and seeds soaked in 0.1 m $MNa_2HPO_4$ for 24 hrs ($T_3$) were visibly enlarged with most of the testa ruptured. French Marigold had higher % germination over African marigold under both lab as well as soil conditions (Table 1). Seeds of $T_1$ treatment had higher germination of 12.66% in African Marigold and 9.67% in French Marigold over the control treatment (72.5% and 74.75%) under laboratory conditions, where as in field conditions African Marigold showed increased germination of 146% in $T_1$ treatment, 130% in $T_2$ and 98% in $T_3$ treatment over the control (26.0%) treatment. In case of French Marigold, a germination hike of 197% was recorded in $T_1$ treatment, 138.8% in $T_2$ treatment and 125.24% in $T_3$ treatment over the control treatment $T_4$ where it was 25.75% only.

In all the treatments ($T_1$, $T_2$, $T_3$) seeds germinated 2-3 days earlier in case of African Marigold, where as 1-2 days in French marigold over the dry seed sowing ($T_4$) (Fig :1). With regard to the speed of germination, all the treatments had more than 70% increase over the control in both the species. Seed-soaking in distilled water treatment had increased the vigour to 77% in African Marigold and 79.3% in French Marigold over the control (Table 1).

In all the four planting dates, the seed treatments reduced the days to first flowering and 50% flowering from the transplanting

Table 1: Effect of Seed Treatments on Seedling Characters in African Mrigold (A.M) and French Marigold (FM) under different Sowing Dates

| Character / Treatment | Germination (%) (Lab Conditions) | | Speed of Grmination (Seed Vigour) | | Field Establishment (%) | |
|---|---|---|---|---|---|---|
| | AM | FM | AM | FM | AM | FM |
| $T_1$ | 83.00 | 82.75 | 16.64<br>(61.5%) | 20.79<br>(76.5%) | 93.83 | 98.97 |
| $T_2$ | 81.25 | 80.00 | 15.71<br>(57.0%) | 16.93<br>(61.5%) | 89.56 | 93.92 |
| $T_3$ | 79.00 | 79.00 | 14.35<br>(47.0%) | 15.75<br>(58%) | 84.69 | 91.21 |
| $T_4$ | 72.50 | 74.75 | 3.84<br>(26.0%) | 4.31<br>(25.75%) | 88.17 | 97.20 |
| CD ± (P=0.05) | 0.50 | 0.74 | 0.32 | 0.08 | 0.55 | 0.89 |

Note : Values in parenthesis indicate the germination percentage under Soil (open field) Conditions.

Table 2 : Effect of Seed Treatments on Flowering and Yield in African Marigold (AM) and French Marigold (FM) at different Planting Dates.

| Character / Treatment | From Transplanting (in days) First Flowering | | From Transplanting (in days) 50% Flowering | | Flower Diameter (Cm) | | Flower Yield (Tonnes / ha) | | Seed Yield (Kg $ha^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | AM | FM | AM | FM | AM | FM | AM | FM | AM | FM |
| $T_1$ | 70.25 | 61.83 | 92.17 | 76.08 | 6.74 | 3.68 | 15.3 | 11.0 | 364.8 | 425.3 |
| $T_2$ | 71.67 | 65.08 | 92.83 | 79.00 | 5.80 | 3.61 | 11.6 | 9.1 | 294.7 | 329.5 |
| $T_3$ | 74.67 | 66.17 | 93.18 | 79.33 | 5.94 | 3.62 | 8.9 | 8.0 | 226.4 | 272.5 |
| $T_4$ | 77.25 | 69.75 | 98.50 | 79.42 | 6.34 | 3.63 | 14.3 | 10.6 | 326.1 | 394.3 |
| CD±=(P=0.05) | 0.32 | 0.39 | 0.39 | 0.48 | 0.54 | 0.02 | 0.75 | 0.28 | 13.33 | 9.50 |

Seed Treatments

$T_1$ = Soaking seeds in distilled water for 24 hours
$T_2$ = Soaking seeds in 0.1 m M $KNO_3$ for 24 hours
$T_3$ = Soaking seeds in 0.1 m M $Na_2HPO_4$ for 24 hours
$T_4$ = Dry seed (Control)

Table 3: Effect of Storage and Hydration (H) on per cent germination of Hydrated Dried (H-d0 Seeds of French Marigold and African Marigold

| Seed Storage | African Marigold | | French Marigold | |
|---|---|---|---|---|
| | AM | FM | AM | FM |
| Octo'98 (Initial) | 72.0 | 86.0 | 72.0 | 76.0 |
| Dec' 98 | 72.0 | 78.0 | 72.0 | 75.0 |
| Feb' 98 | 70.0 | 74.0 | 72.0 | 72.0 |
| April' 99 | 63.0 | 66.6 | 58.0 | 59.0 |
| CD ± (P=0.05) | 1.22 | 0.86 | 0.197 | 0.139 |

compared to control in both the Marigolds. French Marigold flowered earlier than African Marigold in all the treatments (Table 2). Soaking seeds in distilled water for 24hrs resulted in early flowering of 7 days in both the Marigolds over the first flowering of untreated check (77 and 69 days respectively). Similarly 50% flowering was also earlier by 5 days in African and 3 days in French Marigolds over the check (98.5 and 79.42 days respectively).

Flower diameter was not affected significantly by the seed treatment except soaking seed in distilled water for 24 hrs treatment ($T_1$). African Marigold had higher flower diameter over French Marigold in all the treatments (Table 2). Flower diameter in other treatments varied from 5.80 cm to 5.94 cm in African Marigold and 3.62 cm to 3.61 cm in French Marigold which were at par with that of untreated check (6.34 cm and 3.63 cm in African and French Marigold respectively).

Both the Marigold species showed reduction in germination over storage and followed the same trend. Re-hydration for 24 hrs before keeping for germination resulted in higher germination in both the species. Potential capacity for rapid germination was also followed in a decreasing trend in both the Marigold species (Table 3).

The delay in germination and late flowering of dry sown seeds might have resulted from slower reactivation of essential enzymes. Heydecker and Coolbear (1977) reported that hydration of seeds during priming enhanced the embryo's ability to synthesise proteins and RNA resulting in earlier germination even under unfavourable environments. Deterioration of seed is manifested in the reduction of germination as well as vigour. Vigour is an important component of seed quality as it determines the planting value of a seed lot. However, in the absence of any standard recommended test, vigour is determined by several attributes such as seedling growth, susceptibility to accelerated ageing and other biochemical and physiological measures (Abdul - Baki and Anderson, 1972 and Roberts, 1983). Since transplanting is practiced in marigold, seedling vigour is an important character for ensuring satisfactory establishment in the field. Hydration treatments, in water, osmoticum or salt solution with or without dehydration have been reported to be effective to varying extents in a number of field crops and vegetables (Heydecker and Coolbar, 1977, Nagar *et al.* 1998).

Information on the efficacy of hydration treatments in flower seed is scanty (Paramesh *et al.* 1994). In the present study, significant enhancement in speed of germination, final % germination and vigour were seen with simple hydration for 24 hrs or with two cycles of hydration.

Seed treatments did not significantly affect the field establishment of Marigold except in $T_1$ treatment (Table 1). The field establishment percentage in other treatments varied from 84.69% - 89.56% which were at par with that of control (88.17%) in African Marigold, where as in French Marigold $T_2$ and $T_3$ treatments had 93.92% and 91.2% which is significantly lower than the control treatment (97.20%).

Among all the treatments, French Marigold resulted in higher field establishment per cent over African Marigold, which might be due to the favourable microclimate created by its bushy habit more number of leaves which are linear are lanceolate type with short internodes.

Flower and seed yield attributes in both the Marigolds were found to be greatly influenced by the seed treatments (Table 2). Among the different seed treatments (Table 2) $T_1$ resulted in higher flower yield (15.3 t $ha^{-1}$) in African

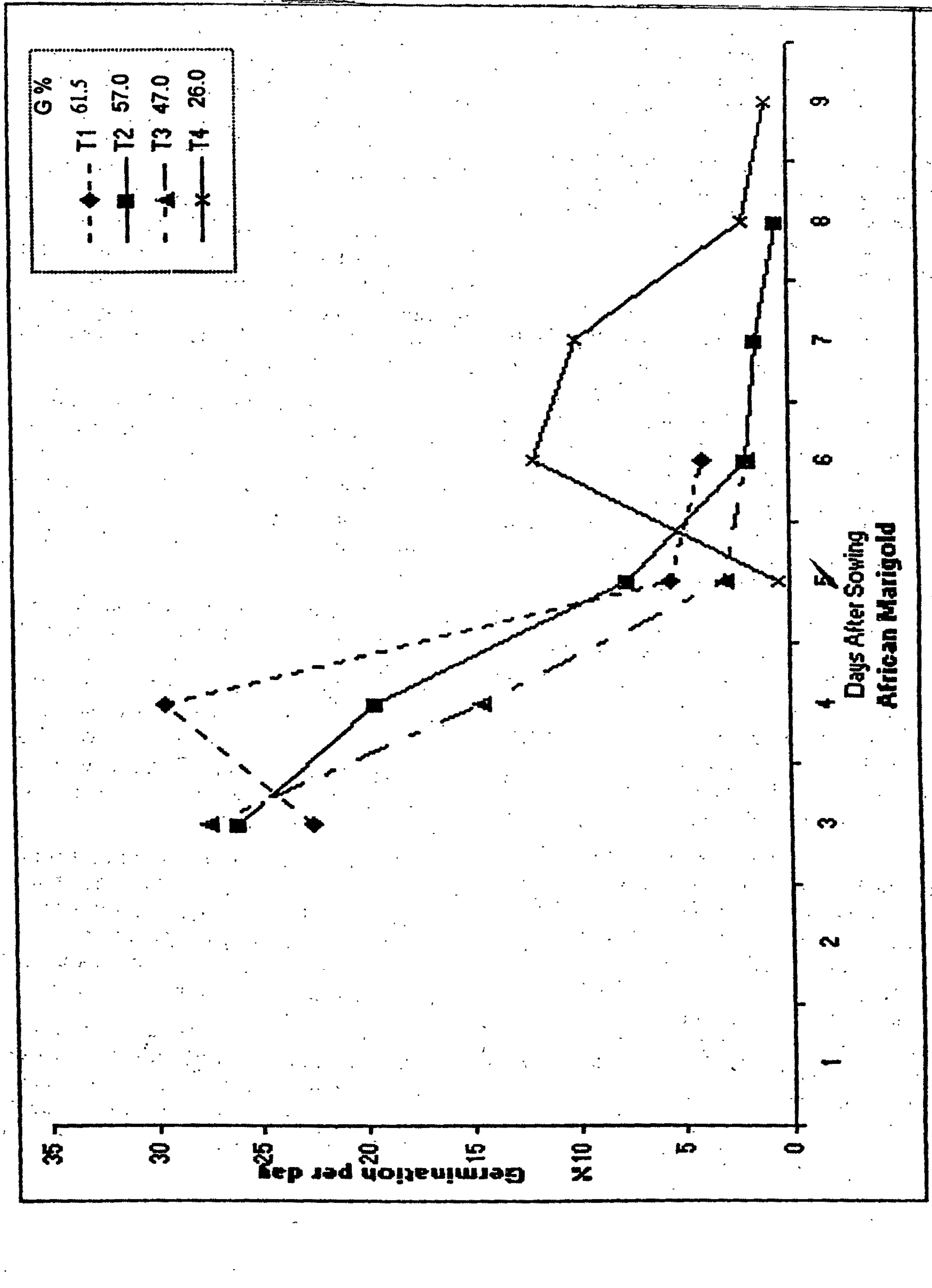
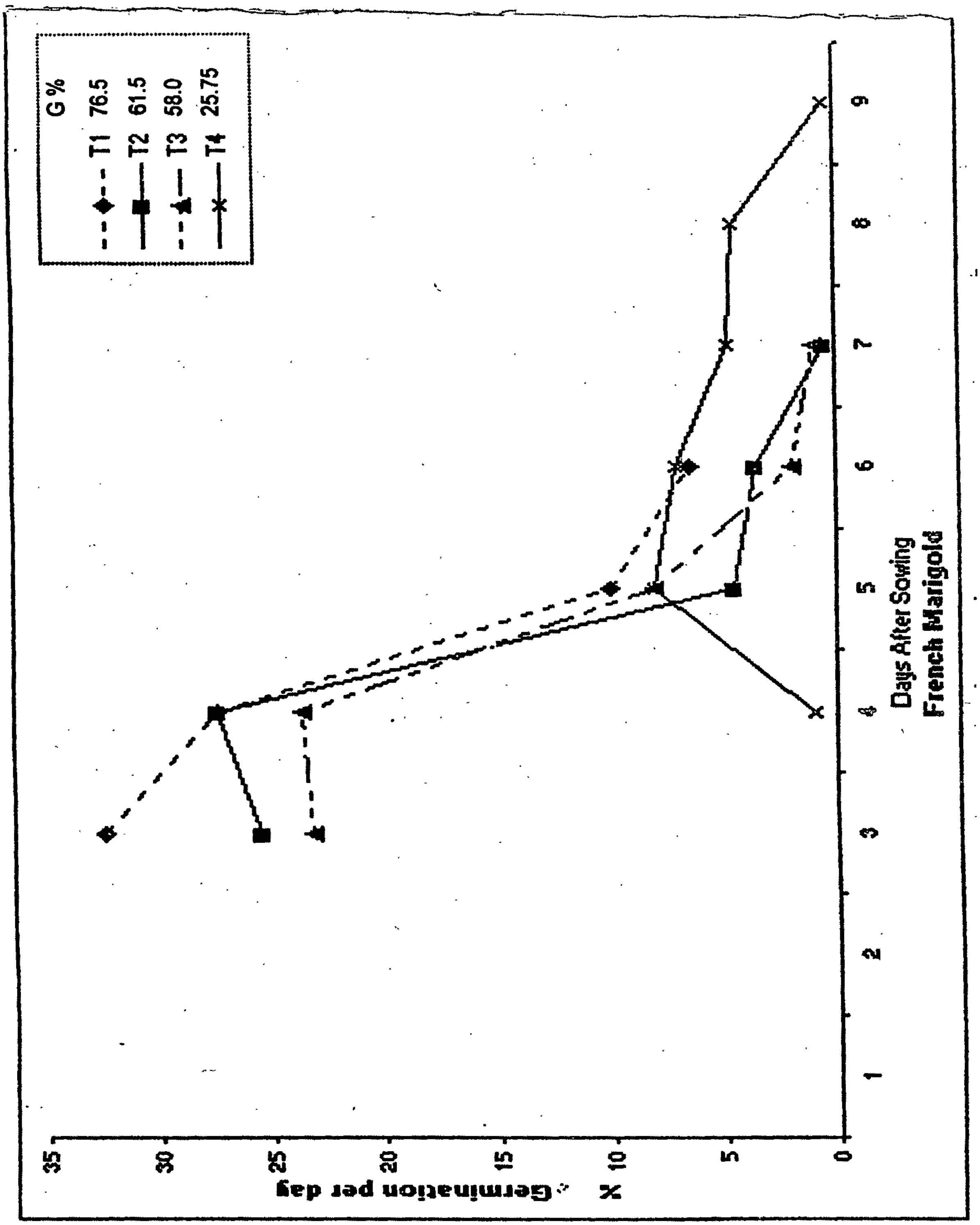


Fig. 1 Per cent Germination per day of African Marigold and French Marigold


G %
T1 76.5
T2 61.5
T3 58.0
T4 25.75
% Germination per day
0
5
10
15
20
25
30
35
1
2
3
4
5
6
7
8
9
Days After Sowing
French Marigold

Marigold and (11t $ha^{-1}$) in French Marigold compared to the control. ( 14.3 t $ha^{-1}$ in African and 10.6 t $ha^{-1}$ French Marigolds). Similar results were obtained with regard to seed yield with $T_1$ treatment in Aftican Marigold (364.8 kg $ha^{-1}$) over control (326.1 kg $ha^{-1}$) and in French Marigold (425.3 Kg $ha^{-1}$) compared to control (394.3 kg $ha^{-1}$).

African Marigold recorded higher fresh yield $ha^{-1}$ than French Marigold where as French Marigold recorded higher seed yield $ha^{-1}$ than African Marigold. Significant improvement in yield and yield attributes was observed with seed treatment (Table 1 & 2). The treatmet soaking seeds in distilled water for 24 hrs showed superiority in increasing field establishment, fresh flower weight and flower yield plant $^{-1}$.

In conclusion the results of the study indicated the superior performance of $T_1$ treatment (seeds soaked in distilled water for 24 hrs) over the control. All the treatments, however, performed well with seeds soaked in 0.1m M $KNO_3$ and 0.1m $MNa_2HPO_4$ for 24 hrs in respect of germination and flowering. All the seed treatments promoted 2-3 days earlier germintion than the control in both the Marigold species. Storage of dried and soaked seeds resulted in faster loss of seed viability and potential capacity for rapid germination.

The senior author is highly grateful to the Indian Council of Agricultural Research (ICAR), New Delhi for sanctioning Junior Research Fellowship (JRF) during the period of the investigation.

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(Received on 20-5-2001 and revised on 15-4-2002 )

The Andhra Agric. J. 49 (3&4) : 219-221, 2002

# *In Vitro* Propagation in Dendrobium Hybrid (Sonia)

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## ABSTRACT

In *vitro* culture of ***Dendrobium*** hybrid (Sonia), among various media tried namely MS, VW and KC, VW medium was found to be superior in respect of early and increased shootlet emergence. Among various growth regulator concentrations, NAA 0.1 mg $l^{-1}$ in combination with BAP 1.0 mg $l^{-1}$ showed superior effect on early leaf formation, number of leaves, number of roots, increased combination with BAP 2.0 mg $l^{-1}$.

Key words : *In Vitro* Propagation in Dendrobium

Orchids have commercial importance for its attractive and long lasting cut flowers. Among orchids, *Dendrobium* is one of the largest diversified genus comprising about 1600 species with great range of variation in respect of flower production. In *Dendrobium*, a variety of crosses were made in order to obtain good quality cut flowers with long lasting life. *Dendrobium* (Sonia) is one such hybrid occupying prime position in cut flower industry. An attempt was made for *in vitro* propagation of *Dendrobium* hybrid (Sonia). Nodal segments were used as explants for *in vitro* propagation of *Dendrobium fimbriatum* var. Oculatum (Kumaria and Tandon, 1994).

## MATERIAL AND METHODS

The mother plants of ***Dendrobium*** hybrid (Sonia) were obtained from M/S Star Orchids, Cochin. The nodal segments were collected from pod grown mother plants in green house. The nodal segments were treated with tween 20 emulsifier followed by washing with sterile distilled water. Then the nodal segments were treated with ethyl alcohol 70 per cent for 30 seconds followed by mercuric chloride 0.1 per cent for eight minutes. Three different basal media namely VW medium (Vacin and Went, 1949), MS medium (Murashige and Skoog, 1962) and KC medium (Knudson, 1946) were tested for initiation of shootlets from nodal segments. Basal media supplemented with different concentrations and combinations of a - naphthalene acetic acid (NAA; 0 $mgl^{-1}$, 0.1 mg $l^{-1}$) 0.5 mg $l^{-1}$ and 1.0 mg $l^{-1}$, 6 - benzyl aminopurine (BAP; 0 mg $l^{-1}$, 0.1 mg $l^{-1}$ 0.5 mg $l^{-1}$ and 1.0 mg $l^{-1}$ and indole -3- acetic acid (IAA; 0 $mgl^{-1}$,0.1 mg $l^{-1}$, 0.5 mg $l^{-1}$ and 1.0 mg $l^{-1}$) and kinetin (KIN; 0 mg $l^{-1}$, 0.1 $mgl^{-1}$ 0.5 mg $l^{-1}$ and 1.0 mg $l^{-1}$) were tested for morphogenesis and number of shootlets per explant. Coconut water was added as an additional supplement. The medium was dispensed into 25 x 100 mm culture test tubes, while liquid medium was dispensed into 100 ml conical flasks. The pH of medium was adjusted to 5.0 for VW and KC media but 5.6 for MS medium. The media were autoclaved separately at 121°C for 20 minutes. The cultures were incubated at 26°C ± 1°C, under 16 h photoperiod provided by cool white fluorescent tubes with a light intensity of 1000 lux. Subculture was carried once in every 3 weeks.

Table 1: Effect of growth regulators (NAA and BAP) on number of days taken for the emergence of the first leaf, the second leaf, the third leaf and the fourth leaf

Genotype : *Dendrobium* hybrid (Sonia) Medium : Vacin and went + CW (15%) (v/v)

| Growth regulator concentration (mg l $^{-1}$) | | Number of days taken for | | | |
|---|---|---|---|---|---|
| | | I leaf | II leaf | III leaf | IV leaf |
| | 0.1 | 37.0 bc | 51.0 b | 63.6 b | 87.3 d |
| NAA | 0.5 | 37.6 bcd | 53.6 bc | 64.3 b | 91.0 f |
| | 1.0 | 38.6 de | 55.0 c | 67.0 c | 85.6 g |
| | 0.1 | 40.0 e | 56.6 c | 70.3 d | 89.3 e |
| NAA | 0.5 | 36.6 b | 54.6 c | 67.0 c | 85.6 c |
| | 1.0 | 33.3 a | 46.6 a | 63.6 b | 83.0 b |
| | 0.1+0.1 | 37.6 bcd | 53.0 bc | 66.0 c | 83.6 b |
| NAA + BAP | 0.1+0.5 | 38.3 cd | 53.3 bc | 64.4 b | 85.3 c |
| | 0.1+1.0 | 32.3 a | 45.0 a | 60.6 a | 77.0 a |
| Control | | 52.7 f | 67.0 d | 83.0 e | 101.6 h |

In a column, means followed by common letter are not significantly different at the 0.05 level by DMRT.

Table 2: Effect of growth regulators (NAA and BAP) on the formation of number of leaves, number of roots, shoot length

Genotype : *Dendrobium* hybrid (Sonia) Medium : Vacin and went + CW (15%) (v/v)

| Growth regulator concentration (mg l $^{-1}$) | | No. of leaves * | No. of roots ** | Shoot length ** (mm) | Root length ** (mm) |
|---|---|---|---|---|---|
| | 0.1 | 3.7 abc | 4.0 ab | 31.5 e | 34.9 a |
| NAA | 0.5 | 3.0 bcd | 3.3 bc | 31.6 e | 31.8 b |
| | 1.0 | 2.6 cd | 3.0 bcd | 31.0 e | 31.3 bc |
| | 0.1 | 2.6 cd | 2.6 bcd | 41.8 c | 29.6 cd |
| BAP | 0.5 | 3.7 abc | 2.3 cde | 42.7 c | 30.3 cd |
| | 1.0 | 4.0 ab | 2.0 de | 47.1 b | 27.1 e |
| | 0.1+0.1 | 3.0 bcd | 3.3 bc | 35.8 d | 32.0 b |
| NAA + BAP | 0.1+0.5 | 3.6 abc | 3.6 ab | 41.5 c | 30.1 cd |
| | 0.1+1.0 | 4.6 a | 4.6 a | 49.5 a | 36.1 a |
| Control | | 2.0 d | 1.3 e | 25.0 f | 21.0 f |

In a column, means followed by common letter are not significantly different at the 0.05 level by DMRT.

*: Measured 85 days after inoculation ** : Measured 100 days after inoculation

Table 3: Effect of growth regulators on multiple shoot induction

Genotype : Dendrobium hybrid (Sonia) Medium : Vacin and went + CW (15%) (v/v)

| Growth regulator | | concentration (mgl $^{-1}$) No. of Shoot per nodal segment | | |
|---|---|---|---|---|
| | 0.1+0.1 | 0.1+0.25 | 0.1+0.5 | 0.25+2.00 |
| NAA + BAP | 1.0 a | 1.3 a | 3.7 a | 6.0 a |
| IAA + BAP | 1.0 a | 1.7 a | 2.3 bc | 4.0 c |
| NAA + KIN | 1.0 a | 1.3 a | 2.0 c | 3.3 c |
| IAA + KIN | 1.0 a | 1.0 a | 3.0 ab | 5.0 b |
| 2, 4-D+ KIN | 1.0 a | 1.0 a | 1.0 d | 1.0 d |
| Control | 1.0 a | 1.0 a | 1.0 d | 1.0 d |

In a column, followed by common letter are not significantly different at th 0.05 level by DMRT.

Uniform sized plantlets of 4-5 centimeters height with well developed roots were taken for hardening. Washed plants were planted in small pots with sufficient holes around containing sterile charcoal, brick pieces and coconut fibre. These pots were placed in a mist chamber by adjusting the relative humidity to 70 - 80 per cent. The experiments were completely Randomised on Factorial Design and the results were analysed by ANOVA and the means were separated by Dunkons Multiple Range Test (DMRT) as suggested by Gomez and Gomez (1984).

## RESULTS AND DISCUSSION

Among different media, the early and increased per cent of initiation of shootlet was noticed in Vacin and Went medium. This might be due to the lower concentration of macro and micro nutrient salts and due to the presence of ammonium salt in VW and KC. The present findings are in agreement with the earlier works of Madhuri and Vasundhara (1990) in ***Dendrobium joannie*** ostenhault.

Among different growth regulator treatments, early formation of first, second, third and fourth leaf as shown in Table 1, more number of leaves, more number of roots an increased shoot length and an increased root length in Table 2 were noticed in NAA 0.1 mg $l^{-1}$, + BAP 1.0 mg $l^{-1}$ treatmental medium. This might be due to the root promoting nature of an auxin which already confirmed by Chung *et al.* (1988) in ***Cymbidium kanaran***. But there was reduction in root number and root length at higher concentration of NAA (or) IAA. This might be due to the inhibitory effect of auxin at supra optimal levels (Kano, 1965).

Among different growth regulators, more number of shoots per nodal segment (multiple shoots) was noticed in VAA 0.25 mg $l^{-1}$ + BAP 2.0 mg $l^{-1}$ (Table 3). The present findings are indicating a stimulatory effect of NAA + BAP and is in agreement with earlier works of Kumaria and Tandon (1994) in *Dendrobium fimbriatum* var. Oculatum.

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(Received on 1-9-2001 and revised on 12-12-2001 )

P 30819

The Andhra Agric. J. 49 (3&4) : 222-224, 2002

# Variability, Heritability and Genetic Advance of Some important Traits in Rice (*Oryza Sativa* L.)

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## ABSTRACT

Variability and heritability studies in 21 genotypes of rice indicated significant differences among all the genotypes for all the characters studied. Considerable amount of variability was observed for all the 14 quantitative characters viz., plant height, days to 50 per cent flowering, number of productive tillers per plant, panicle length, number of spikelets per panicle, number of filled grains per panicle, panicle weight, spikelet sterility per centage, 100 grain weight, dry matter production per plant, grain yield per plant, leaf area per plant, harvest index and length - breadth ratio of grain. High heritability coupled with high genetic advance was observed for number of spikelets per panicle and number of filled grains per panicle, indicating the predominance of additive gene action in controlling these characters. Hence selection could be effective on these traits for improving the yield.

**Key Words :** Variability, Heritability, Genetic Advance, Rice.

Rice is an important cereal crop in Andhra Pradesh. Its yield potential has reached to the maximum possible level. In order to further improve the yield of rice, it is essential to have a thorough knowledge on the variability present in the germ plasm and other trails. The magnitude of heritability indicates the probability with which a genotype can be identified by its phenotypic expression. Genetic advance for any quantitative character can be predicted with the help of heritability, and aids in exercising the necessary selection pressure.

## MATERIAL AND METHODS

The following twenty one genotypes of rice obtained from Agricultural Research Station, Maruteru were studied on a Randomised Block Design with three replications at Agricultural College Farm, Bapatla during *rabi* season 1998 - 1999.

MTU 1001 MTU 1010 IR 64 MTU 3626
MTU 2400 MTU 1366-27-1-2 JGL 245 JGL 246
JGL 496 RNR 9351 RNR M 7 RNR M 22
RGL 9756 RGL 9780 WGL 3938 BPT 1235
NLR 5215-33-5-2 NDLS-1 RDR 763 CB 69010
IET 3116(VIKAS)

[MTU = Maruteru; IR = IRRI; JGL= Jaggityal; RNR= Rajendranagar; RGL = Ragolu; WGL = Warangal; BPT = Bapatla; NLR = Nellore, Ndls = Nandyal; RDR = Rudrur; IET = Kamal]

One month old seedlings were transplanted with a spacing of 15 cm within the row and 20 cm between the rows. Each genotype was planted in four rows of one metre length. Data on five randomly selected plants in each genotype were collected for plant height, days to 50 per cent flowering, number of productive tillers per plant, panicle length, number of spikelets per panicle, number of filled grains per panicle, panicle weight, spikelet sterility percentage, 100 grain weight, dry matter production per plant, grain yield per plant, leaf area per plant, harvest index and length - breadth ratio of grain. The mean of the replications was used for statistical analysis.

Table 1: Analysis of variance for 14 characters in 21 genotypes of rice.

| Source | Df | Plant height (cm) | Days to 50% flowering | No. of Productive tillers/plant | panicle length (cm) | No. of spikelets per panicle | No. of filled grains per panicle | panicle weight (g) | spikelet Sterility % | 100-grain weight (g) | Dry matter production (g) | Grain yield perplant (g) | Leaf area/ plant ($cm^2$) | Harvest index (%) | L/B ratio of grain |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | 20 | 147.7** | 248.45** | 1.96** | 7.36** | 1761.25** | 1273.81** | 0.6897** | 38.70** | 0.4001** | 80.36** | 21.89** | 36.11** | 14.57** | 0.311** |
| Replications | 2 | 76.84 | 12.87 | 7.93 | 36.05 | 1394.96 | 1440.81 | 0.2847 | 28.35 | 0.0279 | 104.6319 | 48.19 | 50.84 | 74.62 | 0.039 |
| Error | 40 | 1.84 | 0.74 | 0.19 | 0.29 | 15.78 | 14.42 | 0.005 | 0.9536 | 0.001 | 4.12 | 0.67 | 1.19 | 4.02 | 0.002 |

** Indicates significanceat 0.01 level

Table 2: Estimates of genotypic and phenotypic coefficients of variation, heritability, genetic advance and genetic advance as per cent of mean in 21 genotypes of rice for 14 characters

| | Character | Genotypic coefficient of variation | Phenotypic coefficient of variation | Heritability | Genetic advance | Genetic advance as per cent of mean |
|---|---|---|---|---|---|---|
| 1 | Plant height (cm) | 8.11 | 8.26 | 96.35 | 14.10 | 16.40 |
| 2 | Days to 50% flowering | 9.07 | 9.11 | 99.11 | 18.64 | 18.61 |
| 3 | Number of productive tillers per plant | 7.33 | 8.47 | 74.97 | 01.37 | 13.07 |
| 4 | Panicle length (cm) | 7.58 | 8.05 | 88.79 | 02.98 | 14.72 |
| 5 | Number of spikelets per panicle | 20.37 | 20.64 | 97.36 | 49.03 | 41.40 |
| 6 | Number of filled grains per panicle | 20.11 | 20.45 | 96.68 | 41.51 | 40.72 |
| 7 | Panicle weight (g) | 17.91 | 18.12 | 97.76 | 00.95 | 36.49 |
| 8 | Spikelet sterility per cent | 25.88 | 26.84 | 92.96 | 07.05 | 51.39 |
| 9 | 100 - grain weight (g) | 16.26 | 16.35 | 98.90 | 00.75 | 33.31 |
| 10 | Dry matter production per plant (g) | 12.30 | 13.26 | 86.05 | 09.63 | 23.51 |
| 11 | Grain yield per plant (g) | 16.92 | 17.71 | 91.34 | 05.24 | 33.31 |
| 12 | Leaf area per plant ($cm^2$) | 11.63 | 12.22 | 90.66 | 06.70 | 22.82 |
| 13 | Harvest Index | 3.97 | 5.81 | 46.64 | 02.64 | 05.59 |
| 14 | Length - Breadth ratio of grain | 11.14 | 11.28 | 97.51 | 00.65 | 22.66 |

## RESULTS AND DISCUSSION

The analysis of variance revealed that the genotypes differed significantly for all the characters, indicating considerable variation among the genotypes for all the characters (Table 1). The phenotypic expression of the character is the result of interaction between the genotype and environment. The genotypic coefficient of variation measures the range of variability available in a crop and also enables to compare the amount of variability present in different characters. In the present study the estimates of phenotypic coefficients of variation for all the characters were higher than the estimates of genotypic coefficients of variation which may be due higher degree of interaction of genotypes with the environment.

It can be seen (Table 2) that spikelet sterility percentage exhibited highest genotypic coefficient of variation (GCV) followed by number of spikelets per panicle, number of filled grains per panicle, panicle weight, grain yield per plant and 100 grain weight indicating presence of high amount of variability for improvement of these characters. Roy *et al* (1995) and Reddy and De (1996) also reported high variability for these traits.

Even though heritability estimates provide an indication of the relative value of selection based on phenotypic expression, heritability and genetic advance when calculated together gives more information in predicting resultant effect of selection (Table 2). In the present study the characters viz., plant height, days to 50 per cent flowering, number of spikelets per panicle and number of filled grains per panicle showed high heritability and high genetic advance coupled with moderate to high variability indicating the predominance of additive gene action and greater response to phenotypic selection and improvement of these traits could be anticipated. Chauhan (1996) and Saravanan and Senthil (1997) reported similar results. Spikelet sterility percentage, exhibited high variability, high heritability and high genetic advance as percentage of mean indicating greater response to phenotypic selection and hence the undesirable effects of spikelet sterility can be overcome by exercing effective selection and discarding the undesirable genotypes. These results are in accordance with that of Mishra *et al* (1996).

Low variability, low heritability and genetic advance was recorded for harvest index indicating the influence of non-additive gene action in controlling the expression of this trait. Hence simple phenotypic selection for this trait may not be fruitful as this character is highly influenced by the environment. Similar results were reported by Selvarani and Rangasamy (1997).

Productive tillers per plant, panicle length, panicle weight, 100 grain weight, dry matter production per plant and leaf area per plant exhibited moderate range of variability, high heritability and low genetic advance indicating the presence of both additive and non-additive gene action, hence simple selection for these traits would be less effective. These results are in accordance with Sarma *et al* (1996) and Saravanan and Senthil (1997).

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(Received on 12-4-2000 and revised on 15-3-2001.)

The Andhra Agric. J. 49 (3&4) : 225 - 227, 2002

# Correlation and Path Coefficient Studies in 45 Genotypes of Roselle (*Hibiscus Sabdariffa* L.)

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## ABSTRACT

Correlation studies between yield and eigt quantitative characters revealed that fibre yield per plant exhibited positive and significant association with plant height, green plant weight, basal stem diameter, number of nodes and inter nodal length. Path coefficient analysis revealed, high positive direct effects of green plant weight, basal stem diameter, number of nodes and inter nodal length on fibre yield. Green plant weight, number of nodes, basal stem diameter, inter nodal length, fibre length and fibre -wood ratio exhibited high positive indirect effect through plant height. Hence selection for yield improvement based on green plant weight, plant height, basal stem diameter, number of nodes and inter nodal length would be effective.

**Key Words :** Roselle, genotypes, correlation, path coefficient analysis.

Yield is a complex character and polygenic nature of inheritance. This necessiaties a deeper insight into the nature of variability present in the germplasm and association of yield with its components before launching any breeding program. The extent of association between yield and its attributes can be known through correlation studies. Information on the direct and indirect effects contributed by each character to yield can be obtained through path coefficient analysis. This will be an added advantage for improvement of the fibre yield.

## MATERIAL AND METHODS

The material used in the investigation comprised of 45 diverse Roselle (*Hibiscus sabdariffa* L) genotypes obtained from Agricultural Research Station, Amadalavalasa. This experiment was conducted at the Agricultural College Farm, Bapatla in a Randomized Block Design replicated thrice. Each genotype in each replication was sown in three rows, with a row length of 3 meters. The characters studied are plant height, basal stem diameter, number of nodes per plant, inter nodal length, green plant weight, days to 50% flowering, fibre length, fibre - wood ratio and fibre yield per plant. Data was recorded on five plants in each genotype in each replication selected from the middle row and their means were used for statistical analysis.

## RESULTS AND DISCUSSIONS

The genotypic and phenotypic correlation coefficients were presented in Table 1. The direct and indirect effects of quantitative characters on fibre yield were presented in Table 2. In general the results revealed that the estimates of genotypic correlation coefficient were higher for almost all the characters under study. Fibre yield per plant exhibited high positive significant correlation with all the traits except days to 50%

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Table 1: Estimates of phenotypic and genotypic correlation coefficients between yield and yield components from 45 genotypes of roselle.

| Characters | Green Plant weight | No. of nodes | Basal stem diameter | Inter nodal length | Days to 50% flowering | Fibre length | Fibre wood ratio | Fibre yield per plant |
|---|---|---|---|---|---|---|---|---|
| Plant height | 0.7651**<br>(0.7733)** | 0.3403*<br>(0.3340)* | 0.3810**<br>(0.3867)** | 0.6145**<br>(0.6324)** | 0.0059<br>(0.0055) | 0.9832**<br>(1.0016)** | 0.0705<br>(0.0702) | 0.6621**<br>(0.6743)** |
| Green plant weight | | 0.3646*<br>(0.3769)** | 0.4655**<br>(0.4730)** | 0.3908**<br>(0.3979)** | -0.0332<br>(-0.0331) | 0.7587**<br>(0.7671)** | 0.1840<br>(0.1881) | 0.9245**<br>(0.9367)** |
| No. of nodes | | | 0.0808<br>(0.0823) | -0.5258**<br>(-0.5133)** | 0.0016<br>(0.0053) | 0.3028*<br>(0.3133)* | -0.0086<br>(-0.0088) | 0.3690*<br>(0.3863)** |
| Basal stem diameter | | | | 0.2647<br>(0.2729) | -0.2479<br>(-0.2524) | 0.3965**<br>(0.4058)** | -0.1099<br>(-0.1112) | 0.5404**<br>(0.5536)** |
| Internodal length | | | | | 0.0184<br>(0.0139) | 0.6293**<br>(0.6499)** | 0.0753<br>(0.0754) | 0.2970*<br>(0.3034)* |
| Days to 50% flowering | | | | | | -0.0330<br>(-0.0330) | -0.1413<br>(-0.1454) | -0.0021<br>(-0.0017) |
| Fibre length | | | | | | | 0.0914<br>(0.0884) | 0.6591**<br>(0.6663)** |
| Fibre - wood ratio | | | | | | | | 0.2118<br>(0.1889) |

Values in parenthesis are genotypic correlations
*&** Significant at (0.05) and (0.01) respectively

Table 2: Estimates of direct and indirect effects between yield and yield components in 45 genotypes of roselle.

| Characters | Plant height | Green plant weight | Nodes per plant | Basal stem diameter | Inter nodal length | Days to 50% flowering | Fibre length | Fibre wood ratio | Correlation with fibre yield per plant |
|---|---|---|---|---|---|---|---|---|---|
| Plant height | **-0.4717**<br>**(-0.7584)** | 0.6692<br>(0.7038) | 0.1162<br>(0.1547) | 0.0786<br>(0.0772) | 0.1958<br>(0.2994) | 0.0005<br>(0.0005) | 0.0669<br>(0.1931) | 0.0065<br>(0.0040) | 0.6621<br>(0.6743) |
| Green plant weight | -0.3609<br>(-0.5865) | **0.8747**<br>**(0.9102)** | 0.1245<br>(0.1745) | 0.0961<br>(0.0944) | 0.1245<br>(0.1883) | -0.0030<br>(-0.0029) | 0.0516<br>(0.1479) | 0.0170<br>(0.0108) | 0.9245<br>(0.9367) |
| No. of nodes | -0.1605<br>(-0.2533) | 0.3189<br>(0.3430) | **0.3415**<br>**(0.4631)** | 0.0167<br>(0.0164) | -0.1675<br>(-0.2430) | 0.0001<br>(-0.0005) | 0.0206<br>(0.0600) | -0.0008<br>(-0.0005) | 0.3690<br>(0.3863) |
| Basal stem diameter | -0.1797<br>(-0.2933) | 0.4072<br>(0.4305) | 0.0276<br>(0.0381) | **0.2064**<br>**(0.1997)** | 0.0843<br>(0.1292) | -0.0222<br>(-0.0224) | 0.0270<br>(0.0782) | -0.0101<br>(-0.0064) | 0.5404<br>(0.5536) |
| Internodal length | -0.2899<br>(-0.4796) | 0.3419<br>(0.3621) | -0.1796<br>(-0.2377) | 0.0546<br>(0.0545) | **0.3186**<br>**(0.4733)** | 0.0016<br>(0.0012) | 0.0428<br>(0.1253) | 0.0069<br>(0.0043) | 0.2970<br>(0.3034) |
| Days to 50% flowering | -0.0028<br>(-0.0042) | -0.0290<br>(-0.0301) | 0.0050<br>(0.0024) | -0.0512<br>(-0.0504) | 0.0059<br>(0.0066) | **0.0897**<br>**(0.0887)** | -0.0022<br>(-0.0064) | -0.0130<br>(-0.0083) | -0.0021<br>(-0.0017) |
| Fibre length | -0.4638<br>(-0.7596) | 0.6636<br>(0.6982) | 0.1034<br>(0.1442) | 0.0818<br>(0.0810) | 0.2005<br>(0.3076) | -0.0030<br>(-0.0029) | **0.0680**<br>**(0.1928)** | 0.0084<br>(0.0051) | 0.6591<br>(0.6663) |
| Fibre - wood ratio | -0.0330<br>(-0.0532) | 0.1609<br>(0.1712) | -0.0029<br>(-0.0041) | -0.0227<br>(-0.0222) | 0.0240<br>(0.0357) | -0.0127<br>(-0.0129) | 0.0062<br>(0.0170) | **0.0922**<br>**(0.0574)** | 0.2118<br>(0.1889) |

Values in parenthesis are genotypic direct and indirect effects.
Values in thick are direct effects.

flowering (-0.0021) and fibre - wood ratio (0.2118). Plant height, green plant weight, basal stem diameter, fiber length, inter nodal length are positively and significantly inter related with each other. Fibre - wood ratio is having positive association with green plant weight and fibre length. Days to 50% flowering exhibited mostly negative and very low association with all other characters.

Green plant weight, nodes per plant, inter nodal length and basal stem diameter exhibited highly positive direct effects on fibre yield per plant. Green plant weight showed very high positive direct effect on yield, where as fibre length showed very low positive direct effect on yield. Plant height exhibited negative direct effect on fibre yield. The indirect effects of green plant weight, no. of nodes, basal stem diameter, inter nodal length, fibre length and fibre - wood ratio were positive through plant height. Plant height showed high negative indirect effect through fibre length. These results are in conformity with the findings of Sasmal and Chakrabarthy (1978), Lu *et al* (1990) in *kenaf*, Basu Chaudhury (1979), Mandal *et al* (1980), Chaudhury *et al* (1981) and Dastidar and Bhaduri (1983) in Jute.

From the results, it can be concluded that green plant weight, basal stem diameter, number of nodes and inter nodal length exhibited positive and significant association with fibre yield and positive direct effects on fibre yield along with positive indirect effects through other characters. Hence selection for yield improvement based on these characters would be beneficial. Plant height is having high negative direct effect on yield but is showing close positive association with yield. This positive association is due to high positive indirect effects through all other characters. Hence, plant height also can be used for effecting yield improvement.

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(Received on 20-7-2000 and revised on 19-9-2001.)

The Andhra Agric. J. 49 (3&4) : 228 - 236, 2002

# Characterization and Classification of Some Soils in a Part of Krishna District, Andhra Pradesh

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## ABSTRACT

Six representative pedons located in a part of Krishna Basin were selected for their characterization and classification. Red soils (pedons 2, 3 and 6) distributed in upper pediplain had shallow depth, dark reddish - brown colour, sandy loam to sandy clay loam texture and granular to sub-angular blocky structure. Black soils (pedons 1, 4 and 5) located in lower pediplain were deep, dark to very dark grayish brown colour in colour clay in texture and sub-angular blocky to angular blocky in structure. Red soils had high bulk density and lower total pore space, water holding capacity, volume expansion and sticky point than the black soils. Black soils had higher pH, $CaCO_3$, cation exchange capacity and base saturation than the red soils. Calcium was the dominant cation on exchange complex in all the pedons. Red soils had higher silica and lower sesquioxide content than black soils. The soils were classified as Vertic Haplustepts and Typic Haplusterts in lower pediplain and Lithic Haplustepts in upper pediplain.

**Key Words :** Characterization; Classification, soils.

Soils of Krishna district of Andhra Pradesh are among the most intensively cultivated soils of the state with paddy as the major crop along with several other important commercial crops . But, data concerning the characterization and classification of these soils is scanty. With this back ground an investigation was taken up to study the nutrient status of these soils.

Six pedons were selected in the mandal for collection of horizonwise samples in the villages of Kanumuru, Tarlapadu, Chennavaram, Dundiralapadu, Gadevarigudem and Gosaveedu. Soil sample were analysed for their nutrient status employing standard procedures.

## MATERIAL AND METHODS

The study area, Gampalagudem in Krishna District of Andhra Pradesh, is situated between 16° 58' 42" to 17° 5' 6" N latitude and 80° 31' 22" to 80° 40' 31" East longitude. Climate of the area is semi-arid mansoonic with distinct summer, winter and rainy seasons. Mean annual rainfall is 1090 mm. Rainfall distribution is markedly seasonal with more than 75 per cent received during June to September. Soil moisture regime is Ustic and the soil temperature regime is iso-hyperthermic. Land scape of the study area include two distinct physiographic units viz., upper pediplain and lower pediplain.

Red soils (pedons 2,3 and 6) are present on the gently slopping (3-4%) upper pediplain where as black soils are distributed in lower pediplains with very gently slopping (1-3%) terrain. Soils on the upper pediplain were developed from granite-gneissic parent material mixed with sand stone and quartzite, where as soils on lower pediplain originated from granite-gneissic complex mixed with schist and calcareous murrum. Pendons 1-6 were located at Kanumuru, Tarlapadu, Chennavaram, Dundiralapadu, Gadevarigudem and Gosaveedu village respectively in Gampalgudem mandal.

Table 1 Summary of morphological features of pedons

| Pedon & Horizon | Depth(m) | Colour Moist | Texture | Structure | Dry | Consistence Moist | Wet | Effervescences | Boundary | Other features |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 Ap | 0.00 - 0.13 | 10YR 3/2 | scl | sbk | sh | ti | s&p | eo | cs | 0.5-1cm wide |
| $B_{11}$ | 0.13 - 0.31 | 10YR 3/2 | scl | sbk | h | ti | s&p | eo | gs | cracks upto 52cm |
| $B_{12}$ | 0.31 - 0.54 | 10YR 3/2 | sc | sbk | h | ti | s&p | e | gw | pressure faces in |
| $B_{21}$ | 0.54 - 0.75 | 10YR 3/2 | sc | abk | h | ti | s&p | e | cw | lower horizons |
| BC | 0.75 - 1.05 | 10YR 4/2 | c | abk | vh | vti | vs&vp | es | cw | |
| C | 1.05 + | | | | | | | | | |
| 2 Ap | 0.00 - 0.06 | 7.5 YR 4/3 | sl | gr | s | fr | so & po | eo | cs | |
| $B_1$ | 0.06 - 0.16 | 7.5 YR 3/4 | scl | sbk | s | fr | ss & sp | eo | cs | |
| BC | 0.016 - 0.38 | 7.5 YR 3/4 | scl | sbk | h | fi | s& p | e | cw | |
| C | 0.38 + | | | | | | | | | |
| 3 Ap | 0.00 - 0.11 | 7.5 YR 3/4 | sl | gr | l | fr | so & po | eo | cs | |
| $B_1$ | 0.11 - 0.24 | 0.5 YR 3/4 | scl | sbk | sh | fr | ss & sp | e | gs | |
| BC | 0.24 - 0.49 | 0.5 YR 3/4 | scl | sbk | sh | fr | s& p | e | cw | |
| C | 0.49+ | | | | | | | | | |
| 4 Ap | 0.00 - 0.17 | 10YR3/2 | c | sbk | h | fi | s&p | e | cs | gilgai micro relief, |
| $A_{12}$ | 0.17 - 0.45 | 10YR3/2 | c | sbk | vh | fi | s&p | e | gs | 2-3 cm wide cracks |
| $A_{ss1}$ | 0.45 - 0.75 | 10YR3/2 | c | abk | vh | vfi | vs&vp | es | dw | upto 60 cm |
| $A_{ss2}$ | 0.75 - 1.02 | 10YR3/2 | c | abk | eh | vri | vs&vp | ev | dw | intere secting |
| AC | 1.02+ | | | | | | | | | |
| 5 Ap | 0.00 - 0.07 | 10YR3/2 | c | sbk | h | fi | s&p | e | cs | gilgai micro relief, |
| $A_{12}$ | 0.07 - -.32 | 10YR3/2 | c | sbk | h | fi | vs&p | es | ds | 2-3cm wide cracks |
| $A_{13}$ | 0.32 - 0.53 | 10YR3/2 | c | abk | vh | fi | vs&vp | es | gs | upto75 cm, |
| $A_{ss1}$ | 0.53 - 0.76 | 10YR3/2 | c | abk | vh | vfi | vs&vp | ev | dw | dominant |
| $A_{ss2}$ | 0.76 - 1.08 | 10YR3/2 | c | abk | vh | vfi | vs&vp | ev | dw | slickensides in |
| AC | 1.08+ | | | | | | | | | |
| 6 Ap | 0.00 - 0.08 | 7.5 YR 3/4 | c | sl | gr | l | fr | so & po | eo | |
| $B_1$ | 0.08 - 0.19 | 7.5 YR 3/4 | c | sl | sbk | sh | fi | ss & sp | eo | |
| BC | 0.19 - 0.36 | 7.5 YR 3/4 | scl | sbk | s h | fi | s & p | eo | gw | |
| C | 0.36+ | | | | | | | | | |

Morphological characteristics of these soils were described (Soil Survey Staff, 1983) and horizonwise samples were collected. Physical, chemical, physico - chemical characteristics and elemental composition were determined according to the standard procedures. Based on these properties soils were classified according to the soil taxonomy (Soil Survey Staff, 1998).

Table 2 Physical characteristics of the soils (< 2 mm size)

| Pedon & Horizon | Depth(m) | Sand (%) T | Silt (%) | Clay (%) | BD (Mg $m^{-3}$) | PD (Mg $m^{-3}$) | PS (%) | WHC (%) | VE (%) | SP (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 Ap | 0.00 - 0.13 | 57.90 | 12.30 | 29.80 | 1.37 | 2.51 | 43.83 | 31.71 | 23.15 | 18.35 |
| $B_{11}$ | 0.13 - 0.31 | 53.90 | 14.30 | 31.80 | 1.44 | 2.49 | 41.13 | 32.85 | 25.27 | 20.35 |
| $B_{12}$ | 0.31 - 0.54 | 51.00 | 14.50 | 34.50 | 1.42 | 2.56 | 40.32 | 34.15 | 28.27 | 21.96 |
| $B_{21}$ | 0.54 - 0.75 | 45.80 | 16.10 | 38.10 | 1.50 | 2.51 | 39.17 | 36.62 | 30.25 | 24.79 |
| BC | 0.75 - 1.05 | 39.90 | 18.30 | 41.80 | 1.57 | 2.49 | 38.26 | 37.25 | 31.29 | 25.63 |
| 2 Ap | 0.00 - 0.06 | 61.83 | 18.15 | 20.02 | 1.45 | 2.47 | 36.17 | 24.23 | 5.73 | 17.21 |
| $B_1$ | 0.06 - 0.16 | 58.68 | 17.25 | 24.07 | 1.49 | 2.52 | 38.17 | 25.40 | 6.73 | 16.40 |
| BC | 0.16 - 0.38 | 53.06 | 17.12 | 29.82 | 1.56 | 2.46 | 36.77 | 26.84 | 7.53 | 17.53 |
| 3 Ap | 0.00 - 0.11 | 73.80 | 9.80 | 16.40 | 1.48 | 2.39 | 40.26 | 24.17 | 5.47 | 18.31 |
| $B_1$ | 0.11 - 0.24 | 66.30 | 11.35 | 22.35 | 1.59 | 2.36 | 39.83 | 28.32 | 7.12 | 18.97 |
| BC | 0.24 - 0.49 | 55.40 | 17.62 | 26.98 | 1.63 | 2.40 | 37.92 | 30.65 | 7.86 | 20.62 |
| 4 Ap | 0.00 - 0.17 | 24.80 | 25.21 | 49.99 | 1.30 | 2.42 | 45.21 | 56.81 | 32.91 | 28.31 |
| $A_{12}$ | 0.17 - 0.45 | 21.90 | 22.42 | 55.68 | 1.37 | 2.39 | 42.67 | 59.25 | 34.62 | 30.71 |
| $A_{ss1}$ | 0.45 - 0.75 | 20.50 | 21.46 | 58.68 | 1.45 | 2.44 | 40.57 | 61.81 | 36.25 | 26.25 |
| $A_{ss2}$ | 0.75 - 1.02 | 17.60 | 20.71 | 61.09 | 1.50 | 2.47 | 39.27 | 64.76 | 38.35 | 33.95 |
| 5 Ap | 0.00 - 0.07 | 26.00 | 31.50 | 42.50 | 1.31 | 2.39 | 42.25 | 51.62 | 27.82 | 25.71 |
| $A_{12}$ | 0.07 - 0.32 | 23.30 | 30.50 | 46.60 | 1.34 | 2.37 | 41.16 | 53.91 | 29.81 | 26.25 |
| $A_{13}$ | 0.32 - 0.53 | 21.10 | 29.60 | 49.30 | 1.38 | 2.41 | 40.87 | 55.27 | 30.25 | 28.17 |
| $A_{ss1}$ | 0.53 - 0.76 | 19.40 | 28.40 | 52.20 | 1.41 | 2.49 | 38.62 | 56.82 | 33.96 | 29.25 |
| $A_{ss2}$ | 0.76 - 1.08 | 18.40 | 27.30 | 54.30 | 1.47 | 2.46 | 37.15 | 58.53 | 34.62 | 31.26 |
| 6 Ap | 0.00 - 0.08 | 73.85 | 10.20 | 15.95 | 1.45 | 2.36 | 39.81 | 20.51 | 6.86 | 16.25 |
| $B_1$ | 0.08 - 0.19 | 68.65 | 12.42 | 18.93 | 1.52 | 2.39 | 37.16 | 25.94 | 7.92 | 19.25 |
| BC | 0.19 - 0.36 | 62.50 | 14.71 | 22.79 | 1.57 | 2.49 | 34.21 | 27.54 | 9.22 | 21.17 |

## RESULTS AND DISCUSSION

### Morphological characteristics

Morphological characteristics (Table-1) indicate that soils on the upper pediplain were shallow in depth ranging from 0.36 to 0.49m (pedons 2,3 and 6) and were dark reddish brown to dark brown in color (5YR 3/4, 7.5 YR 3/4). Soils on the lower pediplain were deep (1.02 - 1.08 m) and very dark grayish brown to dark

Table 3 Chemical characteristics of soils

| Pedon & Horizon | Depth(m) | Organic carbon (g $kg^{-1}$) | Total nitrogen (g $kg^{-1}$) | C/N ratio | PH (1:2) | EC dS $m^{-1}$ (1:2) | $CaCO_3$ (%) |
|---|---|---|---|---|---|---|---|
| 1 Ap | 0.00 - 0.13 | 4.82 | 0.37 | 12.81 | 7.55 | 0.85 | - |
| $B_{11}$ | 0.13 - 0.31 | 4.12 | 0.36 | 11.38 | 7.51 | 0.65 | 2.2 |
| $B_{12}$ | 0.31 - 0.54 | 3.63 | 0.32 | 11.27 | 7.82 | 0.44 | 3.4 |
| $B_{21}$ | 0.75 - 0.75 | 1.97 | 0.28 | 10.35 | 8.23 | 0.51 | 3.8 |
| BC | 0.75 - 1.05 | 1.97 | 0.18 | 10.63 | 8.43 | 0.49 | 4.7 |
| 2 Ap | 0.00 - 0.06 | 3.64 | 0.43 | 7.69 | 7.10 | 0.31 | - |
| $B_1$ | 0.06 - 0.16 | 2.82 | 0.37 | 7.70 | 7.30 | 0.23 | 1.7 |
| BC | 0.16 - 0.38 | 2.48 | 0.30 | 8.05 | 7.28 | 0.21 | 3.3 |
| 3 Ap | 0.00 - 0.11 | 2.92 | 0.39 | 7.42 | 7.63 | 0.47 | - |
| $B_1$ | 0.11 - 0.24 | 2.26 | 0.38 | 6.42 | 7.72 | 0.24 | 4.7 |
| BC | 0.24 - 0.49 | 1.82 | 0.29 | 6.27 | 7.63 | 0.29 | 6.2 |
| 4 Ap | 0.00 - 0.17 | 7.42 | 0.76 | 9.74 | 7.62 | 0.46 | 4.8 |
| $A_{12}$ | 0.17 - 0.45 | 5.22 | 0.54 | 9.63 | 7.65 | 0.24 | 6.8 |
| $A_{ss1}$ | 0.45 - 0.75 | 4.43 | 0.47 | 9.46 | 7.62 | 0.26 | 9.2 |
| $A_{ss2}$ | 0.75 - 1.02 | 3.86 | 0.32 | 11.91 | 7.77 | 0.29 | 7.1 |
| 5 Ap | 0.00 - 0.07 | 6.86 | 0.63 | 10.85 | 7.60 | 0.38 | 8.1 |
| $A_{12}$ | 0.07 - 0.32 | 6.24 | 0.67 | 9.35 | 7.90 | 0.56 | 11.6 |
| $A_{13}$ | 0.32 - 0.53 | 5.81 | 0.62 | 9.32 | 8.00 | 0.41 | 12.7 |
| $A_{ss1}$ | 0.53 - 0.76 | 4.41 | 0.56 | 7.82 | 8.10 | 0.42 | 13.6 |
| $A_{ss2}$ | 0.76 - 1.08 | 4.27 | 0.48 | 8.84 | 8.20 | 0.45 | 13.8 |
| 6 Ap | 0.00 - 0.08 | 4.21 | 0.49 | 8.61 | 7.40 | 0.64 | - |
| $B_1$ | 0.08 0.19 | 3.12 | 0.40 | 7.47 | 7.43 | 0.36 | 1.2 |
| BC | 0.19 - 0.36 | 1.86 | 0.27 | 6.92 | 7.79 | 0.29 | 2.1 |

grayish brown in colour (10 YR 4/2 10 YR 3/2). Non-availability of adequate amount of water for prolonged period in the gently slopping soils associated with removal of finer particles and their deposition at lower pediplain have resulted in shallow soils in upper pediplain and deeper soils in lower pediplain. Presence of clay - humus complexes in soils (Subbaiah and Manickam, 1992) and impeded drainage as evident from lower colour values (3 & 4) and croma (2) imparted black colour to the soils on lower pediplain (Diwakar and Singh, 1994). Occurrence of iron oxides at various hydrated forms might have resulted in dark brown colour to the soils on upper pediplain (Walia and Rao, 1996).

Table 4 : Electro - chemical characteristics of the soils

| Pedon & Horizon | Depth (m) | CEC (cmol $(P^+)kg^{-1}$) | Exchangeable bases (cmol $(P^+)kg^{-1}$) | | | | BS (%) | ESP | CEC/Clay |
|---|---|---|---|---|---|---|---|---|---|
| | | | $Ca^{++}$ | $Mg^{++}$ | $Na^+$ | $K^+$ | | | |
| 1 Ap | 0.00 - 0.13 | 27.83 | 15.21 | 6.71 | 2.60 | 0.87 | 91.26 | 9.34 | 0.93 |
| $B_{11}$ | 0.13 - 0.31 | 31.36 | 17.33 | 7.84 | 3.04 | 0.66 | 92.11 | 9.69 | 0.99 |
| $B_{12}$ | 0.31 - 0.54 | 34.17 | 18.32 | 8.42 | 4.44 | 0.57 | 91.88 | 12.84 | 0.99 |
| $B_{21}$ | 0.54 - 0.75 | 36.15 | 19.45 | 8.54 | 4.85 | 0.53 | 92.30 | 13.41 | 0.95 |
| BC | 0.75 - 1.05 | 37.88 | 21.20 | 8.25 | 4.67 | 0.41 | 93.84 | 12.32 | 0.91 |
| 2 Ap | 0.00 - 0.06 | 13.36 | 6.01 | 3.95 | 0.71 | 0.49 | 83.56 | 5.31 | 0.67 |
| $B_1$ | 0.06 - 0.16 | 15.88 | 8.63 | 4.05 | 0.87 | 0.36 | 87.60 | 5.47 | 0.66 |
| BC | 0.16 - 0.38 | 19.90 | 10.96 | 5.95 | 0.94 | 0.29 | 91.16 | 4.72 | 0.67 |
| 3 Ap | 0.00 - 0.11 | 11.24 | 6.92 | 2.17 | 0.52 | 0.54 | 90.37 | 4.62 | 0.68 |
| $B_1$ | 0.11 - 0.24 | 15.57 | 9.91 | 2.33 | 0.61 | 0.41 | 85.13 | 3.91 | 0.69 |
| BC | 0.24 - 0.49 | 17.59 | 10.52 | 3.4 | 0.96 | 0,39 | 84.71 | 5.45 | 0.65 |
| 4 Ap | 0.00 - 0.17 | 50.87 | 35.91 | 9.02 | 0.99 | 0.54 | 91.35 | 1.94 | 1.02 |
| $A_{12}$ | 0.17 - 0.45 | 56.17 | 38.94 | 11.26 | 1,13 | 0.43 | 92.14 | 2.00 | 1.00 |
| $A_{ss1}$ | 0.45 - 0.75 | 59.87 | 40.87 | 13.75 | 1.47 | 0.38 | 94.32 | 2.46 | 1.03 |
| $A_{ss2}$ | 0.75 - 1.02 | 63.15 | 41.85 | 14.75 | 1.62 | 0.35 | 92.75 | 2.56 | 1.03 |
| 5 Ap | 0.00 - 0.07 | 46.27 | 32.95 | 8.41 | 1.41 | 0.41 | 93.32 | 3.05 | 1.09 |
| $A_{12}$ | 0.07 - 0.32 | 50.83 | 36.50 | 10.90 | 1.57 | 0.32 | 96.09 | 3.09 | 1.09 |
| $A_{13}$ | 0.32 - 0.53 | 52.78 | 37.33 | 11.61 | 1.62 | 0.29 | 96.35 | 3.06 | 1.07 |
| $A_{ss1}$ | 0.53 - 0.76 | 57.45 | 40.45 | 13.72 | 1.64 | 0.22 | 97.49 | 2.84 | 1.10 |
| $A_{ss2}$ | 0.76 - 1.08 | 59.45 | 41.45 | 13.91 | 1.60 | 0.19 | 96.12 | 2.69 | 1.09 |
| 6 Ap | 0.00 - 0.08 | 11.04 | 6.17 | 2.27 | 0.56 | 0.38 | 84.79 | 5.07 | 0.69 |
| $B_1$ | 0.08 - 0.19 | 13.39 | 7.54 | 2.63 | 0.61 | 0.22 | 82.17 | 4.55 | 0.70 |
| BC | 0.19 - 0.36 | 15.74 | 8.77 | 3.02 | 0.65 | 0.19 | 80.20 | 4.12 | 0.69 |

In A-B-C profiles the texture varied from sandy loam to sandy clay loam in surface horizons and sandy clay loam to clay in the sub-surface horizons, where as texture was clay through out depth in A-C profiles. Soils derived from sand stone and quartzite were coarse textured than those formed from fine textured parent material (Thakre *et al.*, 1998). Translocation of finer particles to lower horizons in coarse textured soils derived from resistant parent material could have resulted in relatively finer texture in lower horizons. Uniform texture throughout depth in fine textured soils (pedons 4 and 5) can be attributed to pedoturbation (Buol *et al.*, 1980), but gradual increase in clay content with depth might be due to enhanced chemical

Table 5 Chemical cpmposition of the soils

| Pedon & Horizon | Depth(m) | $SiO_2$ (%) | $R_2O_3$ (%) | $Al_2O_3$ (%) | $Fe_2O_3$ (%) | Molar ratios | |
|---|---|---|---|---|---|---|---|
| | | | | | | $SiO_2/R_2O_3$ | $SiO_2/Al_2O_3$ |
| 1 Ap | 0.00 - 0.13 | 71.81 | 22.91 | 18.52 | 4.39 | 6.17 | 6.61 |
| $B_{11}$ | 0.13 - 0.31 | 69.72 | 24.36 | 19.75 | 4.61 | 5.71 | 5.98 |
| $B_{12}$ | 0.31 - 0.54 | 67.30 | 25.78 | 20.85 | 4.93 | 5.24 | 5.49 |
| $B_{21}$ | 0.54 - 0.75 | 65.20 | 27.83 | 23.51 | 4.32 | 4.70 | 4.74 |
| BC | 0.75 - 1.05 | 63.13 | 29.77 | 24.59 | 5.18 | 4.23 | 4.37 |
| 2 Ap | 0.00 - 0.06 | 74.30 | 22.50 | 16.27 | 5.78 | 6.76 | 7.75 |
| $B_1$ | 0.06 - 0.16 | 71.11 | 24.75 | 18.52 | 6.23 | 5.42 | 6.33 |
| BC | 0.16 - 0.38 | 69.22 | 27.80 | 19.63 | 7.87 | 5.00 | 5.99 |
| 3 Ap | 0.00 - 0.11 | 72.41 | 21.81 | 14.10 | 6.71 | 6.67 | 8.69 |
| $B_1$ | 0.11 - 0.24 | 69.24 | 23.61 | 15.70 | 7.91 | 6.21 | 7.66 |
| BC | 0.24 - 0.49 | 66.20 | 26.17 | 17.82 | 8.35 | 5.23 | 6.61 |
| 4 Ap | 0.00 - 0.17 | 63.96 | 29.87 | 25.29 | 4.58 | 4.28 | 4.29 |
| $A_{12}$ | 0.17 - 0.45 | 59.74 | 32.97 | 27.56 | 5.41 | 3.64 | 3.69 |
| $A_{ss1}$ | 0.45 - 0.75 | 57.83 | 34.56 | 28.59 | 5.97 | 3.34 | 3.44 |
| $A_{ss2}$ | 0.75 - 1.02 | 55.81 | 36.78 | 30.57 | 6.21 | 3.14 | 3.10 |
| 5 Ap | 0.00 - 0.07 | 63.11 | 30.65 | 25.43 | 5.22 | 4.12 | 4.22 |
| $A_{12}$ | 0.07 - 0.32 | 61.72 | 32.38 | 26.91 | 5.47 | 3.82 | 3.89 |
| $A_{13}$ | 0.32 - 0.53 | 60.14 | 33.02 | 27.20 | 5.82 | 3.64 | 3.75 |
| $A_{ss1}$ | 0.53 - 0.76 | 57.02 | 35.54 | 29.52 | 6.07 | 3.20 | 3.29 |
| $A_{ss2}$ | 0.76 - 1.08 | 54.83 | 36.78 | 30.68 | 6.12 | 2.97 | 3.5 |
| 6 Ap | 0.00 - 0.08 | 73.76 | 20.31 | 14.60 | 5.71 | 7.24 | 8.60 |
| $B_1$ | 0.08 0.19 | 71.77 | 24.12 | 17.01 | 7.11 | 5.95 | 7.12 |
| BC | 0.19 - 0.36 | 69.12 | 27.07 | 18.02 | 9.05 | 5.10 | 6.32 |

weathering in presence of moisture available for longer periods. Similar results were earlier reported by Jagadish Prasad *et al.*, (1995) in black soils of Maharashtra.

Pedons 2,3 and 6 had shown granular to sub-granular blocky structure while angular blocky structure was present in pedons 1,4 and 5. Stronger pedality of soils at lower topographic position could be due to more finer fraction in these pedons (Shyampura *et al.*, 1994).

Cracks of 2-3 cm width extending to a depth of 60 to 75 cm, slickensides, wedge -

shaped aggregate were present in profile 4 and 5. Pedon 1 exhibited 0.5-1mm wide cracks upto 52 cm depth and pressure faces in lower horizons.

## Physical characteristics (Table-2)

A-B-C profile had higher total sand content (39.90 - 73.85%) compared to A-C profile (17.60-26.0%) which shows a decreasing trend with depth. Finer fractions dominated (Clay + Silt) mineralogical composition in pedons 4 and 5.

Bulk density values of red soils were higher (1.45 - 1.63 Mg $m^{-3}$) than black soils (1.30 - 1.57 Mg $m^{-3}$) due to their coarse texture associated with lesser porespace (34.21 - 40.26%) compared to the black soils (37.15 - 45.21%). Water holding capacity, volume expansion, sticky point showed an increasing trend with depth in all the pendons but 2,3 and 6 had lower values than others. These can be attributed to increase in clay content with depth in all the pendons and high clay content in pedons 1,4 and 5 (r = 0.97 - WHC Vs clay, r = 0.87 VE vs clay, r = 0.96 SPVs clay).

## Chemical characteristics (Table 3)

The soils were neutral to slightly alkaline in their reaction with pH value ranging for 7.10 to 8.43. An increasing trend with depth was present in pedons 1,5 and 6. Increase in the $CaCO_3$ content with depth could have resited in this trend. Black soils (pedons 1,4 and 5) were alkaline in their reaction due to the presence of $CaCO_3$. Higher pH values inspite of lower $CaCO_3$ content in pedons was due to higher exchangeable sodium on exchange complex (Suresh Kumar and Suman Kumar, 1993).

None of the profiles were saline in nature as their EC values were well below 4 ds/m (0.21 - 0.85 ds/m). The organic carbon status in red soils was 'low'. (1.82 - 4.21 g $kg^{-1}$). In black soils it was low to medium (1.97 - 7.42 g $kg^{-1}$). This was due to formation of stable clay - humus complexes in smectitic black soils. The general low organic carbon content is due to rapid oxidation of organic matter in semi - arid climate. Total nitrogen content and C/N ratio of the soils reflect the changes in organic carbon status with depth in all the pedons. Higher $CaCO_3$ content in lower pediplain soils 4 and 5 was due to calcareous nature of the parent material and also due to higher clay content which led to impeded leaching and consequently accumulation of $CaCO_3$ in lower horizon (Chattopadhya *et al.* 1996).

Pedons 4 and 5 showed higher CEC values (Table 4) 46.27 to 63.15 C mol (p+)$kg^{-1}$ than pedons, 2,3 and 6 (11.44 - 19.90 C mol (p+)$kg^{-1}$) than Pedon 1 had intermediate range 27.83 to 37.88 C mol (p+)$kg^{-1}$. All the profiles exhibited increasing trend with depth. These variations can be attributed to the type of clay, content of the clay (r=0.99, clay + silt r=.095) of the respective pedons and depth wise trends. Calcium was dominant cation on the exchange complex followed by $Mg^{2+}$, $Na^+$ and $K^+$. Calcium usually dominated the exchange complex in soils of semi - arid region (Sharma *et al.*, 1996). Slow weathering of mica and fixation of released potassium might have resulted in low exchangeable Potassium status (Subbaiah, 1984). Black soils exhibited higher base - saturation (91.26 - 97.49%) compared to red soils (80.25 - 91.16%). This can be attributed to variations in pH of the soils (r+0.75). Similar relationship was earlier reported by Chamuah *et al.*, (1996) in Brahmaputra valley soils of Assam.

**Chemical composition (Table 5)**

Pedons 2,3 and 6 were more siliceous (66.20 - 74.30 %) than pedons 4 and 5 (54.83 - 63.96 %) while the Pedon 1 exhibited intermediate value. A decreasing trend with depth was observed in all the Pedons. Siliceous nature of the parent material, decrease in sand content with depth (r=0.93) have resulted in trends shown by silica in different soils (Singh *et al.*, 1993). Sesqui - oxide exhibited reverse trend with depth and the values were higher for finer soils. Sesqui - oxide content of the soils varied in accordance with the clay content (Manickam, 1977). Higher molar ratios ($SiO_2/R_2O_3$ and $SiO_2/Al_2O_3$) in red soils varying from 5.99 - 8.69 than black soils (3.05 - 4.29) indicate the siliceous nature of the parent material and earlier stage of weathering (Walia and Rao, 1996). Intermediate values of the ratios for the Pedon 1 were in accordance with its intermediate sand content.

**Classification of Soils**

Based on morphological, physical and chemical characteristics, these soils were classified (Soil Survey Staff, 1998).

Pendons 4 and 5 were keyed out to be a "Vertisols" due to presence of vertic features like cracks of >1 cm width and 50 cm depth, slickensides, >30% clay in all horizons, wedge shaped aggregates gilgai micro - relief. As the soil moisture regime was 'Ustic', they were placed in "Usterts" at suborder level. Absence of salic, gypsic and petro - calcic horizons qualified these soils to be placed in "Haplusterts" great group. Cracking period of less than 210 days/year and absence of lithic contact facilitated these soils to be classified as "Typic Haplusterts".

Because of the presence of diagnostic combic horizon, Pedons 1,2,3 and 6 were classified as "Inceptisols" and subsequently "Ustepts". Absence of duripan or calcic horizon and base saturation of more than 60 per cent allowed them to be placed in 'Haplustepts' great group.

Pedon 1 was classified as "Vertic Haplustept" because of its vertic characteristics and pedons 2,3,6 were placed under 'lithic' sub group of Haplustepts due to the presence of lithic contact within 50 cm depth from the surface.

Pedons 4 and 5 with clay content more than 30% but less than 60% were classified as 'fine' particle size class. Pedons 2,3 and 6 were coarse textured but finer than loamy very fine sand and the clay content was less than 35 per cent. Hence the particle size at family level was loamy. Pedon 1 was classified as "clayey" because of the clay content of more than 35 per cent in control section.

CEC/Clay ratio of >0.7 in pedons 1,4 and 5 indicated its clay mineralogy to be smectitic (SSLIM, 1995) and for the pedons 2,3 and 6 as the CEC/clay ratio lies between 0.5 - 0.7 the mineralogy was 'mixed'.

| Pedon | Classification |
|---|---|
| 1 | Clayey, semectitic, iso-hyperthermic, Vertic Haplustept. |
| 2,3 | loamy, mixed, iso hyperthermic Lithic Haplustept |

4,5 Fine, smectitic, iso-hyperthermic Typic Haplustert

6 Loamy, mixed, iso-hyperthermic Lithic Haplustept

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(Received 5-7-2001 on and revised on 11-12-2001.)

The Andhra Agric. J. 49 (3&4) : 237-240, 2002

# The Morphology, Clay Mineralogy and Taxonomy of Some Soils of Singarayakonda Mandal in Prakasam District of Andhra Pradesh

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## ABSTRACT

The soils of Singarayakonda Mandal had developed from different parent material of granite - gneiss, gneiss with ferruginous concretions and marine deposits. The black soils were deep to very deep, brown to very dark greyish brown, while the red soil were brown to dark reddish brown in colour. The sandy soils were yellowish brown to yellowish brown. The structure was granular, sub - angular blocky to angular blocky and single grain. Smectite and kaolinite were the dominant minerals in clay fraction. The soils were classified as Vertisol, Alfisol, Inceptisol and Entisol.

**Key Words :** Morphology, Clay Mineralogy, Taxonomy, Vertisol, Albisol, Insectisol, Entisol, Smectite, Kaolinite.

Andhra Pradesh is the fifth largest state in India having a total Geographical area 22.7 m.ha. Singarayakonda Mandal of Prakasam District in Andhra Pradesh was confined to semi - arid monsoonic climate of low lying to plain lands. The soils were developed on granite - gneiss, gneiss with ferruginous concretions and marine deposits. Crops like groundnut, mango, tobacco, cotton, black gram and sorghum were grown on these soils. Their morphology, clay mineralogy and classification are presented in this paper.

## MATERIAL AND METHODS

Seven representative pedons were selected in some soils of Singarayakonda Mandal. The morphological characters of each pedon was described as per the guidelines laid down in USDA Soil Survey Manual (Soil Survey Staff, 1998). Horizonwise samples were analysed following standard procedures outlined by Jackson (1973).

## RESULTS AND DISCUSSION

The pedons selected were 1. Singarayakonda, 2. Pakala, 3. Potaiahgaripalem, 4. Kalikavaya, 5. Binginipalli, 6. Old Singarayakonda and 7.Moolaguntapadu. The morphological features of some of the pedons were presented in Table 1. The morphological features of the pedons 2 and 4 were characterised by the presence of AC horizons whereas, pedons 1,3,5,6 and 7 were differentiated as A-B-C horizons. Haploidization, illuviation and *in situ* formation of clay were the pedogenic processes responsible for the formation of different horizons.

The colour of pedons 1,6 and 7 varied from reddish brown to dark reddish brown. This was due to the presence of Iron - oxides. The colour of the pedons 2,3 and 4 varied between dark greyish brown and very dark greyish brown. Sandy soil (pedon 5) exhibited light yellowish brown to yellowish brown colour.

Table 1 : Morphological description of selected pedons (Black soils, red soil and sandy soil)
Pedon : (Vertisol - location: Potaihgaripalem)

| Pedon & Horizon | Depth (m) | Colour | | Texture | Structure | | | Consistence | | | Efferve sence | Roots | | Pores | | Boundary |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Moist | Dry | | G | S | T | Wet | Moist | Dry | | Size | Quantity | Size | Quantity | |
| Ap | 0.00 - 0.08 | 10YR 4/2 | 10YR 4/2 | scl | 2 | m | sbk | s p | f | sh | e | c | m | m | m | gs |
| $B_1$ | 0.08 - 0.32 | 10YR 4/2 | 10YR 4/2 | scl | 2 | m | sbi | s p | f | h | e | m | c | m | m | gs |
| $B_2$ | 0.32 - 0.64 | 10YR 3/2 | 10YR 4/2 | c | 3 | m | sbk | vs vp | vf | vh | e | f | f | f | f | ds |
| $Bw_1$ | 0.64 - 0.77 | 10YR 3/1 | 10YR 3/1 | c | 3 | m | abk | vs vp | vf | vh | e | f | f | f | f | ds |
| $Bw_2$ | 0.77 - 1.08 | 10YR 3/2 | 10YR 3/2 | c | 3 | m | abk | vs vp | vf | vh | e | f | f | f | f | gs |

Special Features : Cracks which are narrow (1-2cm) and shallow (30.35cm) are observed. Few indistinct slickensides are present in deeper layers.

Pedon : (Inceptisol - Location : Kalikavaya)

| Pedon & Horizon | Depth (m) | Colour | | Texture | Structure | | | Consistence | | | Efferve sence | Roots | | Pores | | Boundary |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Moist | Dry | | G | S | T | Wet | Moist | Dry | | Size | Quantity | Size | Quantity | |
| Ap | 0.00 - 0.011 | 10YR 5/4 | 10YR 6/4 | scl | 1 | f | gr | ss ps | fr | sh | $e_0$ | m | m | f | c | cw |
| $Bw_1$ | 0.11 - 0.24 | 10YR 4/2 | 10YR 4/2 | scl | 1 | f | sbk | s p | fi | h | $e_0$ | m | m | f | c | gs |
| $Bw_2$ | 0.24 - 0.52 | 10YR 3/2 | 10YR 4/2 | c | 2 | m | sbk | s p | fi | h | $e_0$ | f | m | m | c | gs |
| $Bss_1$ | 0.52 - 0.87 | 10YR 4/3 | 10YR 4/2 | c | 2 | m | abk | vs vp | vfi | vh | $e_0$ | f | f | m | c | ds |
| $Bss_2$ | 0.87 - 1.32 | 10YR 3/2 | 10YR 4/2 | c | 2 | m | sbk | vs vp | fi | h | $e_0$ | f | f | f | f | gs |
| AC | 1.32+ | 10YR 4/3 | 10YR 4/2 | c | 2 | m | sbk | vs vp | fi | h | $e_0$ | -- | -- | f | f | -- |

Special Features : Cracks 2.0 to 6.0 mm width to about 30-50 cm deep, slickensides are present in deeper layers.

Pedon : (Entisol - Location: Binginipalli)

| Pedon & Horizon | Depth (m) | Colour |  | Texture | Structure | Consistence |  |  | Efferve sence | Roots |  | Pores |  | Boundary |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Moist | Dry |  |  | Wet | Moist | Dry |  | Size | Quantity | Size | Quantity |  |
| Ap | 0.00 - 0.09 | 10YR 4/4 | 10YR 4/4 | s | Single grain | $s_0 p_0$ | 1 | 1 | -- | m | m | m | c | cd |
| AB | 0.09 - 0.34 | 10YR 3/3 | 10YR 3/3 | s | Single grain | $s_0 p_0$ | 1 | 1 | -- | f | m | f | m | gs |
| $C_1$ | 0.34 - 0.69 | 10YR 3/3 | 10YR 3/3 | s | Single grain | $s_0 p_0$ | 1 | 1 | -- | f | vf | f | m | ds |
| $C_2$ | 0.69 - 0.94 | 10YR 5/4 | 10YR 5/4 | s | Single grain | $s_0 p_0$ | 1 | 1 | -- | f | vf | f | f | ds |
| $C_3$ | 0.94 - 1.36 | 10YR 5/4 | 10YR 5/4 | s | Single grain | $s_0 p_0$ | 1 | 1 | -- | f | f | c | c | ds |
| $C_4$ | 1.36+ | 10YR 5/4 | 10YR 5/4 | s | Single grain | $s_0 p_0$ | 1 | 1 | -- | -- | -- | c | c | -- |

Others : Water stagnation in lower lowyers for short period suring the year.

Pedon : (Alfisol-Location: Old - Singarayakonda)

| Pedon & Horizon | Depth (m) | Colour |  | Texture | Structure |  |  | Consistence |  |  | Efferve sence | Roots |  | Pores |  | Cutons | Boun dary |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Moist | Dry |  | G | S | T | Wet | Moist | Dry |  | Size | Qty. | Size | Qty. |  |  |
| Ap | 0.00 - 0.16 | 2.5YR 3/6 | 2.5YR 4/8 | scl | 1 | m | gr | $s_s p_s$ | fr | s | $e_0$ | m | m | f | f | -- | cs |
| B | 0.16 - 0.54 | 2.5YR 3/6 | 2.5YR 4/6 | scl | 2 | m | sbk | s p | fi | sh | $e_0$ | f | f | f | f | -- | gs |
| $Bt_1$ | 0.54 - 0.78 | 2.5YR 3/6 | 2.5YR 4/4 | scl | 2 | m | sbk | s p | fi | sh | $e_0$ | f | f | f | f | p th | gw |
| $Bt_2$ | 0.78 - 1.02 | 2.5YR 3/6 | 2.5YR 4/4 | sc | 2 | m | sbk | s p | fi | h | $e_0$ | f | f | f | f | p th | cs |
| $Bt_3$ | 1.02 - 1.27 | 2.5YR 4/6 | 2.5YR 4/6 | sc | 2 | m | sbk | s p | fi | h | $e_0$ | f | f | f | f | p th | cs |
| C | 1.27+ |  |  |  |  |  | Weathered granitic-gneiss mixed |  |  |  |  |  |  |  |  |  |  |

Key : Sl-sandy loam; Scl-sandy clay loam, Cl-clay loam, C-clay; S-size, f-fine, m-medium; c-coarse; g-grade; 1-weak; 2-moderate; 3-strong; Ty-type; Sbk-subangular blocky; abk-angular blocky; so & po-non sticky, non plastic; ss & ps - slightly sticky, slightly plastic, Vs&Ps-very sticky, very plastic; e-slight effervescence; cs - clear smooth; gs - gradual smooth; ds - diffused smooth, dw - diffused wavy; ci - clear irregular.

Table 2 : Relative proportion of clay minerals

| Pedon No. | Location | Clay mineral in per cent | | | | |
|---|---|---|---|---|---|---|
| | | Smectite | Illite | Kaolinite | Quartz | Feldspar |
| 1. | Singarayakonda | -- | 20.23 | 79.76 | -- | -- |
| 2. | Pakala | 52.94 | 32.94 | 14.11 | -- | -- |
| 3. | Potaiahgaripalem | 67.24 | 26.72 | 14.65 | -- | -- |
| 4. | Kalikavaya | 67.54 | 14.56 | 7.94 | -- | 9.93 |
| 5. | Binginipalli | -- | 50.00 | 23.52 | 26.47 | -- |
| 6. | Old-Singarayakonda | 17.20 | 21.50 | 61.29 | -- | -- |
| 7. | Modaguntapadu | -- | 18.91 | 74.32 | -- | 6.75 |

| Pedon No. | Location | Taxonomic Unit |
|---|---|---|
| 1. | Singarayakonda | Loamy, kaolinitic, iso-hyperthermic, Typic Haplustalf |
| 2. | Pakala | Fine, smectitic, iso-hyperthermic Chromic Haplustert |
| 3. | Potaiahgaripalem | Fine, smectitc, iso-hyperthermic, Vertic haplustept |
| 4. | Kalikavaya | Fine, smectitic, iso-hyperthermic, Udic haplustert |
| 5. | Binginipalli | Sandy, siliceous, iso-hyperthermic, acquic Ustic psamment |
| 6. | Old Singarayakonda | Loamy, kaolinitic, iso-hyperthermic, Typic Rhodustalf |
| 7. | Moolaguntapadu | Loamy, Kaolinitic, iso-hyperthermic, Typic haplustept |

Pedons 2, 3 and 4 (black soils) were slightly alkaline to moderately alkaline in soil reaction. Pedons 1,6 and 7 (Red soils) were acidic to moderately acidic in soil reaction. Pedons (sandy soil) was neutral in reaction.

The x-ray diffractograms of clay fractions revealed the dominance of kaolinite in clay fraction of pedons 1,6 and 7 and smectite of pedons 2,3 and 4 (Table 2).

Based on the morphology of pedons, climate of the area and analytical data of soils the pedons were classified upto family level following specifications of the Soil Survey Staff (1998).

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(Received on 22-11-2001 and revised on 6-2-2002.)

The Andhra Agric. J. 49 (3&4) : 241-245, 2002

# Life Table Studies of The Diamond Back Moth, *Plutella xylostella* Linn. infesting Mustard

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## ABSTRACT

A field and laboratory investigation was carried out at Bapatla for the develpment of life tables of *Plutella xylostella* Linn. on mustard. The age specific life tables revealed that the period I larvae are more valnerable to natural mortality factors during both the generations. The highest survival rate was observed in pupal stage during both the first and the second generations. The trend index was 9.20 and 9.70 in the first and the second generations, respectively. The generation survival was 0.20 in both the generations. Certain parasitoids and unknown factors were the major mortality factors during larval stage and in pupal stage parasitoids and failure of adult emergence were the major mortality factors. The age specific fecundity tables revealed that the net reproductive rate ($r_0$) and expected rates of increase viz., capacity for increase ($r_c$), intrinsic rate of increase ($r_m$) finite rate of increase ($\lambda$) and weekly multiplication rate ($\lambda^7$) were high in the first generation when compared to the second generation. The population doubling time (DT) was 8.25 days in the first generation, while it was 9.44 days in the second generation.

**Key Words :** Life Table, Diamond Black Moth, Infesting

Mustard is the second important oil seed crop after groundnut which is mostly grown in temperate and warm temperate regions of Asia and Europe. In India it occupies an area of 6.47 m.ha with a production of 5.88 m.t (Directorate of Economics and Statistics, 1995). In Andhra Pradesh, it is grown in 4818 ha with a production of 1415 t (A.P. Statistics Abstract, 1993). The production potential of mustard is often hampered by various pest problems and about 24 insect pests have been reported on mustard at different stages of crop growth (Rai, 1976). The diamond back moth was recorded for the first time by Fletcher, 1914 on cruciferous vegetables and now it enjoys the major pest status.

Life table is the most important tool in the study of insect population dynamics and an useful numerical aid enabling determination of mortality rate in natural population. Series of life tables replicated in time and space increase understanding about the dynamics of an insect population and at the same time reveal the most opportune periods and vulnerable stages for better management of the pests (Harcourt, 1969). Hence, the present study was aimed to develop life tables of *Plutella xylostella* Linn. on mustard for appropriate management.

## MATERIAL AND METHODS

A field and laboratory investigation was conducted at Bapatla for the construction of life table of *Plutella xylostella* Linn. on mustard. A bulk plot of 200 sq.m was raised at Agricultural College Farm, Bapatla, during *rabi* 2000 - 2001. The test variety used was Seeta. All the usual agronomic practices were carried out as per the recommendations. In the bulk plot, sample units of 1 sq.m were marked with pegs at 10 randomly selected places, for recording the absolute population of the pest. For the sampling purpose, the entire larval period was divided into three phases. The first and second instars were considered as period I larvae, third instar as period II larvae and fourth instar as period III larvae. The observations on life table were started with an initial cohort of 100 first instar larvae. Population of the diamond black moth was regularly monitored and observations were taken from the time of pest appearance and continued for two sucessive generations. The census on live and dead larvae were recorded regularly in each phase up to pupation. Simultaneously, a batch of 100 larvae were collected at each count from the rest of bulk plot other than the sample units and reared in the laboratory to observe the extent of parasitism, disease manifestation or other mortality factors. After pupation the pupae were allowed in the field for three to four days to expose them to natural mortality factors and then the pupae were brought to the laboratory and observed further till the adult emergence. If the adults did not emerge the reason for the failure was recorded. With the available data the age specific life tables were constructed according to the format given by Atwal and Bains (1974).

The adults emerged from the field collected pupae were utilized for the construction of age specific fecundity table in the laboratory. After the emergence of adults they were sexed based on abdominal characters. A pair of adults was enclosed in oviposition jars and allowed for oviposition. Each jar was covered with muslin cloth and provided with fresh mustard leaves and cotton swab dipped in 10 per cent honey to serve as adult food and they were changed daily at the time of egg counting. The number of surviving females and number of eggs laid by each female were recorded daily till the death of the female. Per cent egg mortality was also recorded in the laboratory. The data thus obtained were used for the construction of age specific fecundity table according to the format suggested by Birch (1948).

The net reproductive rate ($r_0=\Sigma\ l_x.m_x$), approximate generation time ($Tc = \Sigma x.l_x.m_x / \Sigma\ l_x.m_x$) and capacity for increase ($r_c$) were calculated. The intrinsic rate of increase ($r_m$) was calculated by taking two arbitrary trail values of '$r_c$' differing one point in second decimal place and substituted in the $e^{7\text{-}rmx}.\ l_x m_x$ equation. The trial values on Y-axis and summation value on X-axis were plotted on the graph. The points of trail values against summation were connected with a straight line. The points of trail values against summation were connected with a straight line. The point on the straight line at which it intercepted with the vertical line drawn from the established value, 1096.6 from axis was considered as the accurate '$r_m$' value. From the '$r_m$' value the following parameters were derived by using the formulae given by Atwal and Bains, 1974.

Corrected generation time (T) = $\log_e r_o/r_m$

Finite rate of increase ($\lambda$) = anti $\log_e r_m$

Weekly multiplication rate ($\lambda^7$) = $(e^{\,rm})^7$

Doubling time (DT) = $\log_e 2 / r_m$

## RESULTS AND DISCUSSION

The data regarding the age specific life table are presented in Table 1 and 3. Larval parasitism by *Apanteles* spp. was the major mortality factor during period I larvae in both the generations. The parastisation of period II larvae was greatly reduced when compared to period I larvae. In case of period III larvae, unknown factors acted as major mortality factor. Form the results it is evident that the larval parasitoids preferred younger larvae when compared to later instars which was in confirmity with Chellaiah and Srinivasan (1986). During the pupal stage, Table : 1 Age specific life table of P. xylostella for the first generation on mustard during rabi 2000 - 2001

| Stage of insect (x) | Number living at the beginning ($l_x$) | Factor respon-sible for dx (dxf) | Number dying during x (dx) | dx as a per cent of lx (100 qx) | Survival rate with in x ($S_x$) | Log lx | K-value |
|---|---|---|---|---|---|---|---|
| Expected eggs | 109 | Sterility | 9 | 8.25 | | 2.0374 | 0.0374 |
| Viable eggs | 100 | | | | 0.91 | 2.0000 | |
| Period I Larvae ($N_1$) | 100 | Parasitoids | 25 | 25.00 | | 2.0000 | 0.1250$K_1$ |
| | 75 | Unknown | 17 | 17.00 | | 1.8750 | 0.1116$K_2$ |
| | 58 | Subtotal | 42 | 42.00 | 0.58 | 1.7634 | 0.2366 |
| Period II Larvae | 58 | Parasitoids | 11 | 18.96 | | 1.7634 | 0.0914$K_3$ |
| | 47 | Unknown | 8 | 13.79 | | 1.6720 | 0.0810$K_4$ |
| | 39 | Subtotal | 19 | 32.75 | 0.67 | 1.5910 | 0.1724 |
| Period III larvae | 39 | Parasitoids | 4 | 10.25 | | 1.5910 | 0.0470$K_5$ |
| | 35 | Unknown | 7 | 17.94 | | 1.5440 | 0.0969$K_6$ |
| | 28 | Subtotal | 11 | 28.19 | 0.71 | 1.4471 | 0.1439 |
| Pupa | 28 | Parasitoids | 4 | 14.28 | | 1.4471 | 0.0660$K_7$ |
| | 24 | Fail to emerge | 3 | 10.71 | | 1.3802 | 0.0580$K_8$ |
| | 21 | Subtotal | 7 | 24.99 | 0.75 | 1.3222 | 0.1249 |
| Adults | 21 | | | | | | K=0.7152 |

Sex Ratio (male : female) = 1.1 : 1.0
Average fecundity = 92 eggs/female
Number of females x average fecundity ($N_2$) = 920

Females x 2 ($N_3$) = 20
Trend index (I) $N_2$ / $N_1$ = 9.20
Generation survival (SG) $N_3$/ $N_1$ = 0.20

Table : 2 Age specific fecundity table of P. xylostella for first generation

| Pivotal age in days (x) | $l_x$ | $m_x$ | $l_x m_x$ | $x. l_x m_x$ | Trail $r_m$ 0.08 $e^{7-rmx}.l_x m_x$ | 0.09 $e^{7-rmx}.l_x m_x$ | Accurate $r_m$ 0.084 $e^{7-rmx}.l_x m_x$ |
|---|---|---|---|---|---|---|---|
| 20 | 0.10 | | | | | | |
| 21 | 0.10 | 8.7500 | 0.8750 | 18.3750 | 178.83 | 144.96 | 164.42 |
| 22 | 0.10 | 17.6400 | 1.7640 | 38.8080 | 332.81 | 267.08 | 304.17 |
| 23 | 0.10 | 13.5460 | 1.3546 | 31.1558 | 235.92 | 187.44 | 215.18 |
| 24 | 0.09 | 10.3300 | 1.0330 | 24.7920 | 166.07 | 130.64 | 150.87 |
| 25 | 0.07 | 6.7500 | 0.6750 | 16.8750 | 100.17 | 78.01 | 90.64 |
| 26 | 0.07 | 8.2200 | 0.8220 | 21.3720 | 112.61 | 86.83 | 100.49 |
| 27 | 0.04 | 3.6400 | 0.3640 | 9.8280 | 46.03 | 35.14 | 41.32 |
| 28 | 0.02 | 2.8350 | 0.2835 | 7.9380 | 33.09 | 25.01 | 29.59 |
| 29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | | | 7.1711 | 169.14 | 1205.53 | 955.11 | 1096.68 |

Net reproductive rate ($r_0$) = 7.1711
Mean duration of generation ($T_c$) = 23.58 days
Capacity for increase ($r_c$) = 0.0835
Instrinsic rate of increase ($r_m$) = 0.0840

Finite rate of increase ($\lambda$) = 1.0876
Weekly multiplication rate ($\lambda^7$) = 1.8003
Corrected generation Time (T) = 23.45 days
Doubling time (DT) = 8.25 days

Table 3 : Age specific life table of *P. xylostella* for the second generation on mustard during *rabi* 2000 - 2001

| Stage of insect (x) | Number living at the beginning ($l_x$) | Factor responsible for dx (dxf) | Number dying during x (dx) | dx as a per cent of lx (100 qx) | Survival rate with in x ($S_x$) | Log lx | K-value |
|---|---|---|---|---|---|---|---|
| Expected eggs | 108 | Sterility | 8 | 7.22 | | 2.0334 | 0.0334 |
| Viable eggs | 100 | | | | 0.92 | 2.0000 | |
| Period I Larvae ($N_1$) | 100 | Parasitoids | 22 | 22.00 | | 2.0000 | 0.1079$K_1$ |
| | 78 | Unknown | 18 | 18.00 | | 1.8920 | 0.1139$K_2$ |
| | 60 | Subtotal | 40 | 40.00 | 0.60 | 1.7781 | 0.2219 |
| Period II Larvae | 60 | Parasitoids | 7 | 11.66 | | 1.7781 | 0.0539$K_3$ |
| | 53 | Unknown | 9 | 15.00 | | 1.7242 | 0.0809$K_4$ |
| | 44 | Subtotal | 16 | 26.66 | 0.73 | 1.6434 | 0.1347 |
| Period III larvae | 44 | Parasitoids | 6 | 13.63 | | 1.6434 | 0.0637$K_5$ |
| | 38 | Unknown | 8 | 18.18 | | 1.5997 | 0.1026$K_6$ |
| | 30 | Subtotal | 14 | 31.81 | 0.68 | 1.4771 | 0.1663 |
| Pupa | 30 | Parasitoids | 5 | 16.66 | | 1.4771 | 0.0792$K_7$ |
| | 25 | Fail to emerge | 3 | 10.00 | | 1.3979 | 0.0555$K_8$ |
| | 22 | Subtotal | 8 | 26.66 | 0.73 | 1.3424 | 0.1347 |
| Adults | 22 | | | | | | K=0.6910 |

Sex Ratio (mele : female) = 1.16 : 1.0

Females x 2 ($N_3$) = 20

Average fecundity = 97 eggs/female

Number of females x average fecundity ($N_2$) = 970

Trend index (I) $N_2 / N_1$ = 9.70

Generation survival (SG) $N_3 / N_1$ = 0.20

Table 4: Age specific fecundity table of P. xylostella for the second generation

| Pivotal age in days (x) | $l_x$ | $m_x$ | $x\,l_x m_x$ | $x.\,l_x m_x$ | Trail $r_m$ 0.07 $e^{7-rmx}.l_x m_x$ | 0.08 $e^{7-rmx}.l_x m_x$ | Accurate $r_m$ 0.034 $e^{7-rmx}.l_x m_x$ |
|---|---|---|---|---|---|---|---|
| 20 | | | | | | | |
| 21 | 0.102 | 9.5900 | 0.9781 | 20.54 | 246.62 | 199.90 | 229.62s |
| 22 | 0.102 | 13.0900 | 1.3351 | 29.37 | 313.87 | 251.89 | 291.25 |
| 23 | 0.102 | 10.2250 | 1.0429 | 23.98 | 228.60 | 181.89 | 211.41 |
| 24 | 0.102 | 8.8200 | 0.8996 | 21.59 | 183.86 | 144.63 | 169.45 |
| 25 | 0.092 | 6.7500 | 0.6210 | 15.52 | 118.34 | 92.16 | 108.69 |
| 26 | 0.060 | 4.1300 | 0.2478 | 6.44 | 44.02 | 33.94 | 40.30 |
| 27 | 0.040 | 6.1400 | 0.2456 | 6.63 | 40.68 | 31.06 | 37.11 |
| 28 | 0.020 | 3.1400 | 0.0628 | 1.75 | 9.70 | 7.33 | 8.81 |
| 29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | | | 5.4329 | 125.82 | 1185.69 | 942.54 | 1096.64 |

Net reproductive rate ($r_0$) = 5.4329

Mean duration of generation ($T_c$) = 23.15 days

Capacity for increase ($r_c$) = 0.0731

Instrinsic rate of increase ($r_m$) = 0.0734

Finite rate of increase ($\lambda$) = 1.0761

Weekly multiplication rate ($\lambda^7$) = 1.6716

Corrected generation Time (T) = 23.05 days

Doubling time (DT) = 9.44 days

parasitoids and failure of adult emergence from pupae were the major mortality factors which accounted for 24.99 and 26.66 per cent of total mortality. Chellaiah and Srinivasan (1986) reported that an eulophid pupal parasitoid, *Tetrastichus sokolowskii* acts as a major mortality factor during pupal stage.

Among all the stages, the survival rate (Sx) was high in pupal stage next to egg stage in both the generations. Reddy and Singh (1998) earlier reported the highest survival rate in pupal stage. The K-value was the highest in period I larvae, where as it was low in case of pupal stage in both the first and second generations.

The sex ratio revealed that the population of males was high during both the generations. The average fecundity was 92 and 97 eggs / female in the first and the second generations, respectively and maximum egg laying was observed on the third day after adult emergence in both the generations. The results are in approximation with the reports of Yadav *et al.* 1974.

The trend index (I) was positive in both the generations and also more than one which indicated that the mortality factors that operating in mustard ecosystem were not effective in suppressing the pest population. Similar results were obtained by Reddy (1995). The generation survival was 0.20 in both the generations which indicated that comparatively high proportion of individuals had successfully completed their generation.

The data pertaining to the age specific fecundity tables are presented in Table 2 and 4. The net reproductive rate ($r_o$) during first generation was 7.17 but declined to 5.43 in the second generation. The intrinsic rate of increase ($r_m$) was 0.0841 in the first generation as against 0.0734 females / female / day in the second generation. The capacity for increase ($r_c$), finite rate of increase ($\lambda$) and weekly multiplication rate ($\lambda^7$) also showed similar trend. The corrected generation time (T) was around 23 days in both the generations. The population doubling time was low in the first generation, which was only 8.25 days as against 9.44 days in the second generation which was probably due to low temperature prevailing during the second generation. The results of the present study are in agreement with Reddy (1995) who reported higher expected rates of increase and less doubling time in the first generation when compared to the second generation.

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(Received 5-11-2001 on and revised on 18-2-2002.)

The Andhra Agric. J. 49 (3&4) : 246 - 249, 2002

# Bioefficacy of Monocrotophos Applied Through Different High Volume Sprayers Against Sucking Pests of Tobacco

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## ABSTRACT

A field experiment was conducted during *rabi* 1998 - 99 at CTRI Research Station Guntur, to study the bioefficacy of monocrotophos (36 WSC) applied through hand compression, knapsack, Hi-tech and akela sprayers with single and double duromist nozzles at 30 and 40 PSI against *Myzus persicae* Sulzer and *Bemesia tabaci* (Gennadius) on tobacco. Hi-tech sprayer with double nozzle at 40 PSI proved to be significantly superior over all other treatments by recording the highest reduction of aphids, 85.05 per cent and whiteflies 88.04 per cent over untreated check.

**Key Words :** Bioefficacy, Sucking pests of Tabacco

Among the commercial crops grown in India tobacco (*Nicotiana tabacum* Linn.) is the important one. Andhra Pradesh stands first both in area and production by cultivating about 120.6 thousand hectares with an annual production of 136.6 million kg of leaf (Annual Report, CTRI 1997-98). During the intial stages the tobacco crop is infested by the sucking pests like aphids, *M. Persicae* and whitefly, *B. Tabaci.* For controlling of these pests insecticides must be applied with a suitable sprayer in order to increase the maximum coverage per unit time, effectiveness of the operator and to reduce the problems like pesticide residues and environmental pollution. Besides the type of sprayer the type of nozzle and spray pressure are most important for achieving better control of the pests. Hence detailed studies were conducted to study the bioefficacy of monocrotophos applied through high volume sprayer for the effective management of sucking pests of tobacco.

## MATERIAL AND METHODS

The experiment was laid out in a simple Randomised Block Design with 14 treatments and three replications during *rabi* 1998 -99 at CTRI Research Station, Guntur. Four high volume sprayers i.e hand compression, knapsack, Hi-tech and akela sprayers were tested. All the sprayers, except akela were tested with single and double nozzle both at 30 and 40 PSI. One untreated check was also maintained. Monocrotophos 36 (WSC) was sprayed by mixing 5.2 ml of formulation in three litres of water for each plot. The spray schedule commenced from 70 days after planting and subsequent two sprayings at 10 days interval. The treatmental details are as follows.

$T_1$ - Hand compression sprayer with single nozzle at 30 PSI.
$T_2$ - Hand Compression sprayer with single nozzle at 40 PSI
$T_3$ - Hand Compression sprayer with double nozzle at 30 PSI
$T_4$ - Hand Compression sprayer with double nozzle at 40 PSI
$T_5$ - Kanapsack sprayer with single nozzle at 30 PSI
$T_6$ - Kanapsack sprayer with single nozzle at 40 PSI

Table 1 Efficacy of spray appliances against aphid, M. Persicae.

| Treatments | Pretreatment population counts | Mean per cent reduction 3 DAS | | | |
|---|---|---|---|---|---|
| | | First spraying | Second spraying | Third spraying | Mean of 3 sprayings |
| $T_1$ | 336.6 | 44.38 | 18.05 | 32.29 | 31.57 |
| | (2.49) | (41.37) | (24.46) | (33.48) | (33.95) |
| $T_2$ | 399.3 | 50.69 | 23.91 | 39.89 | 38.16 |
| | (2.59) | (45.39) | (28.47) | (38.98) | (38.10) |
| $T_3$ | 389.3 | 55.04 | 36.21 | 42.42 | 44.55 |
| | (2.57) | (47.88) | (36.61) | (40.48) | (41.86) |
| $T_4$ | 379.3 | 57.81 | 42.04 | 45.18 | 48.34 |
| | (2.55) | (49.49) | (40.23) | (42.14) | (44.04) |
| $T_5$ | 244.3 | 61.01 | 47.25 | 53.31 | 53.85 |
| | (2.34) | (51.39) | (43.48) | (46.95) | (47.21) |
| $T_6$ | 341.6 | 60.14 | 48.58 | 55.84 | 54.85 |
| | (2.52) | (50.88) | (44.33) | (48.45) | (47.78) |
| $T_7$ | 474.0 | 61.29 | 52.17 | 63.98 | 59.14 |
| | (2.57) | (51.60) | (46.48) | (53.49) | (50.26) |
| $T_8$ | 408.0 | 73.57 | 56.98 | 72.66 | 67.73 |
| | (2.60) | (59.11) | (49.57) | (58.73) | (55.40) |
| $T_9$ | 225.0 | 74.13 | 62.17 | 81.77 | 72.69 |
| | (2.22) | (59.43) | (52.59) | (64.80) | (58.63) |
| $T_{10}$ | 340.3 | 76.80 | 63.49 | 85.09 | 75.12 |
| | (2.42) | (61.27) | (53.53) | (67.38) | (60.31) |
| $T_{11}$ | 282.3 | 71.95 | 68.68 | 88.19 | 78.94 |
| | (2.39) | (63.66) | (56.56) | (70.01) | (62.76) |
| $T_{12}$ | 208.3 | 84.10 | 80.63 | 90.42 | 85.05 |
| | (2.16) | (66.70) | (64.08) | (72.25) | (67.26) |
| $T_{13}$ | 309 | 34.32 | 17.57 | 12.28 | 21.39 |
| | (2.44) | (35.35) | (23.89) | (19.09) | (27.21) |
| $T_{14}$ | 304.0 | 0.00 | 0.00 | 0.00 | 0.00 |
| | (2.44) | (1.81) | (1.81) | (1.81) | (1.81) |
| F-test | NS | Sig. | Sig. | Sig. | Sig. |
| CD (0.05) | | 10.22 | 7.69 | 9.29 | 5.39 |

Figures in parentheses are angular transformed values while for pretreatment are log transformed values.

Table 2 Efficacy of spray appliances against whitefly, B.tabaci

| Treatments | Pretreatment population counts | Mean per cent reduction 3 DAS First spraying | Second spraying | Third spraying | Mean of 3 sprayings |
|---|---|---|---|---|---|
| $T_1$ | 17.6 | 44.5 | 31.40 | 28.96 | 34.95 |
| | (4.13) | (41.81) | (33.98) | (32.52) | (36.22) |
| $T_2$ | 20.0 | 44.20 | 37.47 | 51.66 | 44.44 |
| | (4.40) | (41.66) | (37.14) | (45.96) | (41.77) |
| $T_3$ | 18.6 | 49.79 | 44.75 | 51.85 | 48.79 |
| | (4.23) | (44.89) | (41.75) | (46.07) | (44.29) |
| $T_4$ | 17.6 | 54.10 | 49.55 | 71.42 | 58.07 |
| | (4.10) | (47.36) | (44.74) | (62.77) | (48.51) |
| $T_5$ | 20.6 | 59.27 | 55.71 | 53.23 | 56.07 |
| | (4.43) | (50.34) | (48.34) | (46.91) | (48.51) |
| $T_6$ | 23.6 | 58.41 | 59.66 | 71.06 | 63.04 |
| | (4.80) | (49.86) | (50.68) | (57.56) | (52.57) |
| $T_7$ | 23.6 | 62.72 | 36.37 | 70.00 | 66.36 |
| | (4.76) | (52.35) | (54.71) | (56.92) | (54.58) |
| $T_8$ | 17.6 | 66.43 | 58.19 | 72.56 | 69.06 |
| | (4.13) | (54.60) | (55.84) | (63.99) | (56.56) |
| $T_9$ | 18.3 | 67.89 | 72.69 | 66.66 | 69.08 |
| | (4.20) | (55.49) | (58.62) | (60.60) | (58.23) |
| $T_{10}$ | 21.3 | 70.08 | 74.08 | 61.45 | 68.53 |
| | (4.43) | (56.84) | (59.64) | (52.85) | (56.21) |
| $T_{11}$ | 23.0 | 75.74 | 76.08 | 94.04 | 81.95 |
| | (4.66) | (60.49) | (60.72) | (81.65) | (67.62) |
| $T_{12}$ | 26.3 | 78.80 | 85.32 | 100.00 | 88.04 |
| | (5.03) | (62.59) | (67.55) | (90.00) | (69.76) |
| $T_{13}$ | 17.3 | 41.67 | 26.52 | 33.33 | 33.84 |
| | (4.10) | (40.15) | (29.16) | (34.78) | (35.22) |
| $T_{14}$ | 19.3 | 0.00 | 0.00 | 0.00 | 0.00 |
| | (4.26) | (1.81) | (1.81) | (1.81) | (1.81) |
| F-test | NS | Sig. | Sig. | Sig. | Sig. |
| CD (0.05) | | 3.90 | 10.23 | 37.22 | 10.50 |

Figures in parentheses are angular transformed values while for pretreatment are square root transformed values

$T_7$ - Knapsack sprayer with double nozzle at 30 PSI
$T_8$ - Knapsack sprayer with double nozzle at 40 PSI
$T_9$ - Hi-tech sprayer with single nozzle at 30 PSI
$T_{10}$ - Hi-tech sprayer with single nozzle at 40 PSI
$T_{11}$ - Hi-tech sprayer with double nozzle at 30 PSI
$T_{12}$ - Hi-tech sprayer with double nozzle at 40 PSI
$T_{13}$ - Akela sprayer with single nozzle (farmers practice).
$T_{14}$ - Untreated check.

Population counts were recorded on top three leaves from 10 randomly selected plants in each plot one day before and three days after each spray. Reduction of the pest intensity over pretreatment counts were calculated by using modified Abbott's formula as suggested by Flemming and Ratnakaran (1985) and were subjected to statistical analysis.

## RESULTS AND DISCUSSION

Data (Table 1) revealed that, in all the three sprayings Hi-tech sprayer with double nozzle at 40 PSI was superior by reducing the aphid infestation to an extent of 84.10 per cent after first spraying, 80.63 per cent after second spraying, 90.42 per cent after third spraying. Pooled data of three sprayings revealed that Hi-tech sprayer with double nozzle at 40 PSI was significantly superior over all other treatments by recording the highest per cent reduction of 85.05 over untreated check. The per cent reduction of aphids with knapsack sprayer which reduced the pest incidence in the range of 31.57 and 48.34 per cent, akela sprayer was least effective by reducing the pest incidence to an extent of 21.39 per cent.

The incidence of whiteflies showed (Table 2) that the superiority of Hi-tech sprayer treatment over knapsack and hand compression sprayers. On perusal of the data, it is evident that, Hi-tech sprayer with double nozzle both at 40 and 30 PSI recorded the significant reduction of 88.04 and 81.95 per cent respectively, over untreated check followed by Hi-tech sprayer with single nozzle at 40 and 30 PSI. Akela sprayer though recorded the lowest reduction of 33.84 per cent over untreated check, it was on par with hand compression sprayer with single nozzle at 40 and 30 PSI.

Present findings of superiority of Hi-tech sprayer against sucking pests of tobacco was reported by Raghupathi Rao, 1993-98 against jassids on bhendi, Chari *et. al.* 1996 against *H. armigera* on pigeonpea and Raghupathi Rao *et al*, 1998 against *H. armigera* on cotton and pigeonpea.

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(Received 16-4-200 on and revised on 29-9-2001.)

The Andhra Agric. J. 49 (3&4) : 250 - 255 , 2002

# Biology and Biometrics of larval Parasitoid *Peribaea orbata* (Wiedemann) (Diptera : Techinidae) on *Spodoptera litura* (Fabricius)

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## ABSTRACT

Studies on biolog and biometrics of *Peribaea orbata* (Wied) were carried out under laboratory conditions (29 ±1.5°C). Gestation period, ovilarviposition period, development period of first, second and third instar maggots in the host, pupal period, total life cycle were 3.0 ±1.2, 5.6 ± 1.65, days, 22 ± 1.5, 22 ± 1.25, 67±3.25 hours, 6 ± 1.5 days and about 19 days respectively. The behaviour of larvae inside the host and biometrics of egg, maggots, pupae and adults were studied.

**Key Words :** Biology, Biometrics, Parasitoid. Polyphagous pest.

Among the larval parasitoids of *Spodoptera litura* (Fab.), most common one is *Peribaea orbata* (Wied.) in different agro-climatic conditions of Andhra Pradesh. Since *S. litura* is a polyphagous pest causing severe damage to important cultivated crops, it's control by using *P. orbata* is considered. Hence it is proposed to study the detailed biology and biometrics of *P. orbata* in the laboratory. Hegazi *et al.* (1977) and Rao and Satyanarayana (1989) studied brief biology of this parasitoid on *Spodoptera littoralis* (Boisd.) and *S. litura* (Fab.) respectively. The present studies were undertaken in the Department of Zoology, Nagarjuna University, Guntur at 29 ± 1.5 °C.

## MATERIAL AND METHODS

*S. litura* larvae collected from tomato fields around Guntur (A.P.) were observed in the laboratory for the emergence of parasitoid maggots (Plate 1A) which were allowed to pupate in wooden cages (20x20x20 cm) (Rao and Sudha Rao, 1964) Prepupae washed thoroughly with sodium chloride solution (0.1%) and dried on filter paper were separated individually into glass vials (7cm x 2cm) containing moist acid washed sand and the mouth of the vial was closed by cotton cloth for aeration. As soon as the adult flies were emerged they were fed with cotton swabs dipped in the mixure of honey and sugar solution (0.5% sugar water + 1.5 honey and water (v/v)). Four to five hour old female and one day old male were confined in a glass vial for mating. After mating the female flies were separated and allowed to parasitize the host larvae (5-6) kept separately (instarwise i.e. 3, 4, 5) in petridishes with tomato leaves which in turn were placed in cages separately. The parasitized host larvae were removed daily and fresh larvae along with tomato leaves were provided for parasitisation. The parasitised larvae (Plate 1B) were observed at regular interval of six hours under Bosch & Lamb dissection microscope for recording the development and behaviour of different instars of maggot. Initial and final timings were noted for each and every stage. The prepupal and pupal duration were recorded for 20 individuals. For studying the longevity of adults 20 males and 20 females emerged on the same day were observed separately. The average measurements and data of 20 individuals of different stages of parasitoid were recorded.

## RESULTS AND DISCUSSION

### Egg

Egg was minute, elliptical and milky white with ends nearly round (Fig. 1). The anterior end was slightly narrower than posterior. The egg measured at an average length of 0.44 mm and breadth of 0.16mm. Egg was covered by a thin chorion. The buccopharyngeal armature (BPA) and cuticular spines were clearly visible through the chorion. After gestation period of (3.0 ± 1.2 days) the female started laying eggs on the host dorsum. After two minutes of ovilarviposition, the maggots were hatched out. The adult fly laid 1-5 maggots on each host at a time and1-2 seconds were taken to lay a single maggot. A total of 172 to 198 eggs were laid in the life span of female fly. During oviposition posterior part of the egg emerged first. Ovilarvalposition was continued for 5.6 ± 1.65 days. Parthenogenesis was not observed. Camera lucida drawings were made from fixed specimens.

### Laral Stages

### First instar

It is transparent, elongate and oval. Black mouth hook, black cuticular spines, yellow fat bodies and tracheae were visible. Fresh first instar maggot measured 0.48mm and 0.19mm in length and breadth respectively, whereas the full grown maggot measured 1.85mm in length and 0.65 mm in breadth. BPA extended posteriorly upto second segement as in *Tachina larvarum* L. (Hafez, 1953) and was curved as in *Dichaeteneura leucoptera* Johns. (Thompson, 1953). The BPA is characterized by the presence of an unpaired hook (Plate 1C) without any articulation. Cuticular armature consisted of spines on the last three abdominal segments (Fig. 2) whereas spines were present on all the segements in *Sturmiopsis inferens* Towns. (Rao and Baliga, 1968). Anterior spiracles were inconspicuons and did not open outside. Posterior spiracles were present dorsally on the last segment. Metapneustic respiration was observed. Larva hatched immediately and penetrated into the host body leaving microscopic rupture on the body wall (Rao and Satyanarayana, 1989). The first instar larva after entering into the host moved inside the body cavity. Afer reaching the main tracheal tube near the spiracle of the host larva, it attached itself by its posterior spiracle and the respiratory funel was formed in the host around the parasitoid. In the case of superparasitism a maximum of five respiratory funnels were observed around each spiracle of the host. Posterior part of the parasitoid was lodged in the respiratory funnel and anterior part was directed towards digestive tract of host larva. After 22 ± 1.50 hours the maggot molted by splitting the body wall at its posterior end.

### Second Instar

It was less transparent than first instar. Body elongate, tapering anteriorly and grew to a maximum of 3.33mm in length and 0.95 mm in breadth. BPA consisted of a pair of bifid mouth hooks. It was characterized by two articulations. The cuticular armature differed from that of the first instar in the absence of spines on the 10th segment (Fig. 3). After 22 ± 1.25 hours the second instar larva molted. Though the anterior spiracles were minute they were prominent than in first instar. However, they were not open outside. In the posterior spiracles three short, clavate spiracular slits were observed opening into the spiracular chamber. Respiration was metapneustic.

### Third Instar

It is stout, fleshy and grew to a maximum length of 9.0mm and breadth of 2.5mm. They were cylindrical with tapering head. Segmentation was more distinct. Fat bodies and salivary glands were well developed. BPA (Plate 1D) was stouter and stronger than second instar maggot. Cuticular armature was prominent and spines were present on all the segments dorsally and ventrally (Fig.4.) This instar lasted for 67 ± 3.25 hours. Anterior spiracles were prominent and reddish brown and located dorsolaterally at the posterior margin of prothoracic segment and each one possessed five papillae. The posterior spiracles were oval and each with three triangular short slits situated dorsally on last segment. Respiration was amphipneustic.

Drastic pathological changes in the host larva were observed during this stage only. The first two instars fed on haemocoelic fluid while third instar fed on contents of body cavity especially the fat bodies. Just before emergence the full grown maggot freed itself from the funnel and wandered in the host body for some time. Parasitized host become progressively more sluggish as maggots grew.

### Emergence of the parasite from the host

Full grown maggot emerged from dorsum of the host cuticle by making a hole with the help of mouth hooks and it took about 20 minutes to emerge. Just before emergence the maggot excreted yellowish fluid in the funnel. During maggot emergence the host larva was restless and did not feed. Immediately after emergence of maggot the host larva showed some relief. After emergence the maggot crawled on the host and then moved away from the host.

Superparasitism was observed. The number of maggots that emerged from a single host varied from 1-19 under laboratory conditions and 1-39 under natural field collections. Jayanth and Nagarkatti (1984) reported 1-12 maggots from a single full grown host larva, while Rao and Satyanarayana (1989) reported 5.5 ± 2.54 maggots.

### Prepupa

Following emergence from host larva the third instar maggot wandered for sometime and pupated in the bottom of the container or in the soil. Prepupal period varied from 2 ± 0.5 hours at the bottom of the container without soil and 1.5 ± 0.5 hours when soil was provided. Prepupal period was short in *P. orbata* when compared with *Sturmiopsis inferens* Towns. (3-6 hours) (Rao and Baliga, 1968).

### Pupa

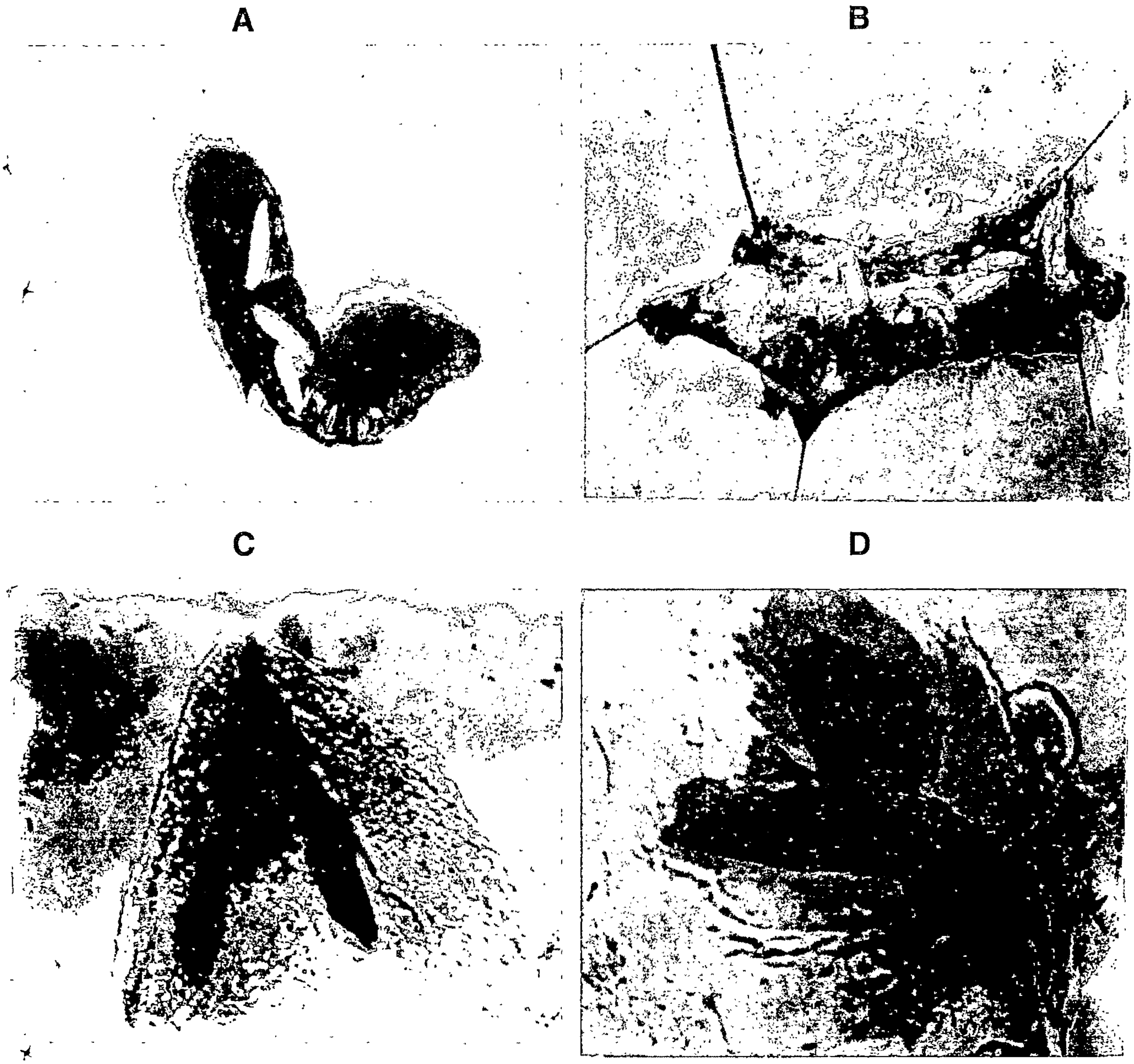
Freshly formed pupa was light yellow and changed to dark brown a day after. Pupa was barrel shapped (Fig.5). The full grown pupa measured 6-7mm in length and 2mm in breadth. Pupal period was 6 ± 1.5 days. Two pairs of spiracles one anterior and other posterior were apparent. Respiration of the pupa was accomplished through the external prothoracic cornicles led into the anterior spiracles, which were the only functional respiratory organs of the pupa.

### Adults

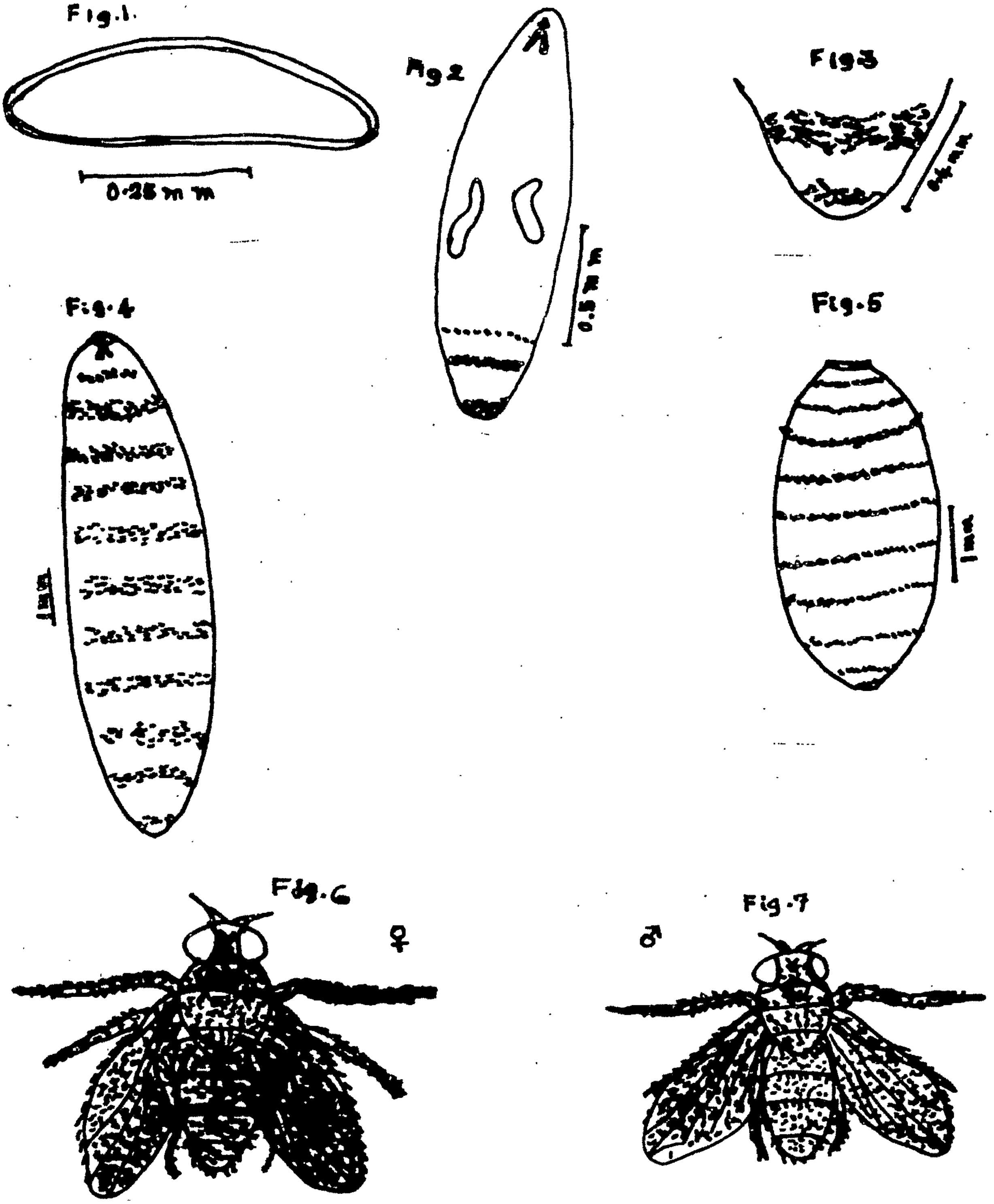
Fully developed adult fly pushed off the operculum present at the anterior end of pupa with legs and head and emerged out. The adults were very active and dark black. Head, thorax and abdomen were light yellow. Body covered with black setae making the fly appear black.

Females (Fig. 6) were slightly bigger (3.9mm x 1.4mm) than males (Fig. 7) (3.5mm x 1.34mm). The abdomen of the female was broad and large, while the male was narrow and small. In proportion with head, antennae of male larger

**PLATE 1**



A : Emergence of parasitoid maggots from the host
B : Parasitoid larvae observed in the dissected host
C : Buccopharyngeal armature of first instar maggot
D: Buccopharyngeal armature of third instar maggot



Figs. 1 to 7 : Peribaea orbata (Wiede.)

1. Egg 2. First instar maggot 3. Second instar maggot
(Posterior part)

4. Third instar maggot 5. Pupa 6. Female fly 7. Male fly

than that of female. In wing the vein $R_{4+5}$ bears eleven macrochaetae on the upper side in female and twelve in male. Claws in the legs of male were stronger than female. Sex ratio was 1:1. Life span of male was 18 ± 1.57 days and it was 24 ± 1.65 days in females. Longevity depended on its degree of development due to superparasitism. Rao and Satyanarayana (1989) observed that the adult life period to be 16.55 ± 1.5 day for males and 18.90 ± 1.61 days for females.

### Mating

Immediately after emergence the flies could not mate. Female fly could mate after 4-5 hours of emergence and the males 1-2 days after emergence. The pair remain in copula for 10 to 48 minutes. The mating changes were more when adults were confined in small vials, than in large cages. It was observed that female could make only once whereas male mate at least with three females. Single mating was enough to enable a female to produce fertilized eggs through out her life. Mating took place during day time between 10.00 am and 4.00pm. During mating the male mounted on the female firmly holding the later by it's legs and clasper. Total life cycle was observed to be about 19 days. The total life period was observed to be 35 days in female and 29 days in male.

## ACKNOWLEDGEMENTS

The author wishes to place on record her deep sense of gratitude to Nagarjuna University for providing necessary facilities for conducting the experiments and University Grants Commission for financial assistance. The help rendered by Late Dr. A.S. Murthy, Reader in Nagarjuna University, Dr. B. Nagalingam and Dr. V. Ramasubba Rao, Department of Entomology, Agricultural College, Bapatla is greatly acknowledged.

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(Received on 28-4-2002 and revised on 3-6-2002.)

The Andhra Agric. J. 49 (3&4) : 256 - 261, 2002

# New Record of Leafhoppers (Cicadellidae : Homoptera) Associated with Pulse Crop-ecosystems in Andhra Pradesh

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## ABSTRACT

Twelve leafhoppers viz., *Deltocephalus* (Recilia) *accuminatus* Dash and Viraktamath, D. (Recilia) *breviculus* Dash and Viraktamath, D. (Recilia) *distinctus* (Motschulsky), *Empoascanara maculifrons* (Motschulsky), *Hecalus arcuatus* (de Motschulsky), *H. ghaurii* Ramasubbarao and Ramakrishnan, *H. Paraumballaensis Ramasubbarao and RamakrishnaBalclutha* parasubrostriata Ramasubbarao and Ramakrishnan, *Nirvana pallida* Melichar, Chlorotettix versicolor Pruthi, Masiripius lugubris (Distant) and Doratulina tolla (Pruthi) are reported for the first time in pulse crop ecosystems of Andhra Pradesh in India. Diagnosis of these leafhoppers were provided.

**Key Words :** Leafhoppers, cicadellidae, pulse crops, Homoptera, New Records.

The leafhoppers (Homoptera : Cicadellidae) are widely distributed and many are serious pests and vectors of diseases of many economic crops. The broad objective of this work is to provide a comprehensive account of leafhopper species commonly found in pulse crops of Andhra Pradesh in India with their diagnostic characters in the form of 'key' for the use of both Economic Entomologists and Extension field workers.

## MATERIAL AND METHODS

The present investigation was conducted on leafhopper fauna associated with pulse crops like greengram (*Vigna radiata* (L.) Wilczek), blackgram (*Vigna mungo* (L.) Hepper), pigeonpea (*Cajanus cajan* (L.) Millsp.), chickpea (*Cicer arietinum* L.) horsegram (Macrotyloma uniflorum (Lam.) Verdc.), Cowpea (Vigna unguiculata (L.)Walp) and soybean (*Clycine max* Merr.) in different pulse growing areas of Andhra Pradesh in India during 1998-2000. The leafhopper collections were made intensively on the above crops with about fifteen to and fro insect net sweepings each time. The leafhoppers were aspirated from the net, killed with benzene swabs and transferred to small glass vials, labelled, brought to the laboratory and dried in an oven at 45 - 50°C for about 4-6 hours and stored. For mounting and preparation of genitalia the procedure advocated by Knight (1965) was adopted. Different parts of male genetalia were observed under research microscope for confirmation of speices identification.

## RESULTS AND DISCUSSION

In the present study 41 species of leafhoppers (Cicadellidae : Homoptera) belonging to 21 genera were collected and identified (Table 1). A perusal of literature indicated that the following 12 leafhoppers were observed for the first time on pulse crops and hence these forms a new record on pulses in Andhra Pradesh.

1 *Deltocephalus (Recilia) accuminatus* Dash and Viraktamath

Table 1 : Leafhoppers associated with pulse crops in Andhra Pradesh

| S.No. | Leaf hopper spies | Associated crops |
|---|---|---|
| 1. | *Austroagallia bifurcata* Sawai Singh and Gill | greengram, pigeonpea |
| 2. | *Aconurella indica* (Pruthi) | blackgram |
| 3. | *A. neosolana* Ramasubbarao and Ramakrishnan | greengram, soybean |
| 4. | *Amrasca devastans* (Distant) | greengram, pigeonpea, blackgram chickpea, soybean, cowpea |
| 5. | *Batracomorphus angustatus* (Osborn) | greengram, pigeonpea |
| 6. | *Balclutha incisa* (Matsumura) | greengram, pigeonpea, blackgram chickpea, soybean, cowpea |
| 7. | *B. pararubrostriata* Ramasubbarao and Ramakrishnan | blackgram |
| 8. | *B. saltuella* (Kirschbaum) | greengram, pigeonpea, blackgram chickpea, soybean, cowpea |
| 9. | *Cicadulina (Cicadulina) bipunctata* (Melichar) | greengram, blackgram |
| 10. | *Cofana unimacultata* (Signoret) | greengram, blackgram |
| 11. | *Deltocephalus (Deltocephalus) vulgaris* Dash and Viraktamath | greengram, blackgram |
| 12. | *D. (Recilia) acuminatus* Dash and Viraktamath | greengram |
| 13. | *D. (R.) breviculus* Dash and Viraktamath | greengram |
| 14. | *D. (R) distinctus Motschulsky* | greengram, blackgram |
| 15. | *D(R.) dorsalis* (Motschulsky) | greengram, blackgram horsegram, chickpea |
| 16. | *D. (R.) subviridis* (Metcalf) | greengram, horsegram,blackgram |
| 17. | *Doratulina apicalis* (Pruthi) | horsegram |
| 18. | *D. rubrolineata* (Distant) | greengram, pigeonpea, blackgram, soybean, cowpea |
| 19. | *D. tolla* (Pruthi) | blackgram |
| 20. | *Empoasca (Empoasca) kerri* Pruthi | greengram,pigeonpea, blackgram, soybean horsegram, cowpea |
| 21. | *E. (E)* motti Pruthi | greengram, pigeonpea, blackgram, soybean |
| 22. | *E. (E.) spirosa* Dworakowska and Viraktamath | greengram, pigeonpea, blackgram, soybean horsegram, cowpea |
| 23. | *Empoascanara indica* (Datta) | greengram, blackgram |
| 24. | *E. maculifrons* (Motschulsky) | greengram |
| 25. | *E. prima* (Distant) | greengram, blackgram |
| 26. | *Exitianus indicus* (Distant) | greengram, blackgram, soybean |
| 27. | *E. nanus* (Distant) | greengram, blackgram |
| 28. | *Goniagnathus punctifer* Walker | greengram |
| 29. | *Hecalus arcuatus* (Motschulsky) | blackgram |
| 30. | *H. ghaurii* Ramasubbarao and Ramakrishnan | blackgram |
| 31. | *H. paraumballaensis* Ramasubbarao and Ramakrishnan | blackgram |
| 32. | *H. porrectus* (Walker) | greengram |
| 33. | *H. prasinus* (Matsumura) | blackgram |
| 34. | *Hishimonus nielsoni* Knight | greengram |
| 35. | *H. phycitis* (Distant) | greengram |
| 36. | *Chlorotettix versicolor* Pruthi | greengram |
| 37. | *Orosius orientalis* (Matsumura) | greengram, blackgram |
| 38. | *Masiripius lugubris* (Distant) | greengram |
| 39. | *Nirvana pallida* Melichar | greengram, pigeonpea |
| 40. | *Nephotettix Virescens* (Distant) | soybean |
| 41. | Seriana jaina (Distant) | greengram, pigeonpea, blackgram horsegram, cowpea |

2 *D. (Recilia) breviculus* Dash and Viraktamath
3 D. *(Recilia)* distinctus (Motschulsky),
4 *Empoascanara maculifrons* (Motschulsky),
5 *Hecalus arcuatus* (de Motschulsky)
6 *H. ghaurii* Ramasubbarao and Ramakrishnan
7 *H. paraumballaensis* Ramasubbarao and Ramakrishnan
8 *Balclutha paraubrostriata* Ramasubbarao and Ramakrishnan
9 *Nirvana pallida* (Melichar)
10 *Chlorotettix versicolor* Pruthi
11 *Masiripius lugubris* (Distant)
12 *Doratulina tolla* (Pruthi)

Rivisionary works on many genera by various workers in India and abroad are available but the literature on consolidated work on specific agro - ecosystem is limited in India. Singh *et al.*, (1993) studied the leafhopper fauna of economic importance and their natural enemies in Karnataka state. In general the diagnostic characters for distinguishing the economically important leafhoppers are lacking. Ramasubba rao *et al.* (2000) reported 26 leafhoppers associated with rice and sugarcane ecosystems from different agro - climatic zones of Andhra Pradesh and provided key for distinguishing all these species. Sudha jacob *et al.* (2000) reported 40 species of leafhoppers from different areas of Andhra Pradesh, associated with oilseed crops like groundnut, castor, sunflower, sesamum, mustrand and niger along with an illustrated key for their identification. In the present investigation 41 leafhoppers were identified on different pulse crops like greengram, blackgram, pigeonpea, chickpea, soybean, horsegram and cowpea from Andhra Pradesh (Table 1). All these leafhoppers can be identified by following the key given by Sudha Jacob *et al.* (2000) except these 12 new records for which the key diagnostic characters along with illustrations are given in this paper. The accurate identification of leafhoppers associated with a particular crop ecosystem is very much needed in order to suggest suitable pest management practices whenever they reach the pest status.

### *Deltocephalus (Recilia) acuminatus* Dash and Viraktamath (Figs. 1 & 2)

Head and thorax orange yellow, vertex with a faint median fuscous markings. Ocelli black, eyes greyish black, face ochraceous and antennal cavity black.

Sternal apodemes at base of abdomen, slender elongate with truncate apices. Aedegal shaft slightly curved, wider at base, gradually narrowed distally to an acutely pointed and spine like, gonopore dorsoapical.

### *Deltocephalus (Recilia) breviculus* Dash and Viraktamath (Figs. 3)

Ochraceous in colour. A sinuate oblique line is present in front on either side of medium line of the vertex. Basal triangles of scutellum brown. Forewings pale ochraceous and veins marginally brown.

Sternal abdominal apodemes with blunt apex. Aedeagal shaft short with heel at base well developed, ventral margin strongly sinuate, dorsal margin rather straight with blunt apex and gonopore subapical.

### *Deltocephalus* (Recilia) *distinctus* (Motschulsky) (Figs. 4 & 5)

Stramineous yellow. Anterior margin of vertex with a black patch, and with three distinct white patches in between. Face black with pale stripes across. Fore wings have a distinct black spot.

Subgenital plates with strongly convex lateral outer margin and are as wide as or wider than straight inner margin. Aedegal shaft gradually tappering and pointed at apex, then slightly curved dorsocaudally, gonopore large and subapical.

**Empoascanara maculifrons (Motschulsky) (Fig. 6)**
**Synomym:** *Typhlocyba maculifrons* Motschulsky

Head yellow, vertex with a large black spot on the margin of vertex and face. Abdomen black and the forewings light grey without any other markings.

Aedeagus with one pair of assymetrical apical processes viz., one longer and the other shorter which arised from the base of longer one rather than from the shaft and gonopore subapical.

**Hecalus arcuatus (de Moschulsky) (Fig. 7)**

Synonyms: *Acocephalus arcuatus* de Motschulsky
*Thomsonella arcuata* Distant
*Parabolocratus arcuatus* (Distant)
*Linnavuoriolla arcuata* (de Motschulsky) Evans
*Varta moshiensis* Rao

Yellowish green with sangunious faceae forming inverted 'v' on vertex, two concentric parabolic lines on pronotum, three longitudinal lines on scutellum. Vertex anterior margin with transverse submarginal dorsal and ventral fuscuous lines. Forewings yellowish green with five veins sangunious, apical 1/3 light brown with faint white spots in apical and anteapica cells, a dark spot at the tip of clavus and two spots on coastal margin.

Aedeagus with two pairs of terminal processes which are subequal in length.

**Hecalus ghuarii Ramasubbarao and Ramakrishnan (Fig. 8)**

The colour varies from yellowish green to green. Vertex and face with submarginal fuscous lines. Eyes with two reddish lines. Forewings subhyaline, black spot at the end of clavus and hindwings hyaline.

Aedeagus with dorsal apodeme long, curved distad, shaft laterally compressed, broader at middle, tapering to apex with a pair of laterally directing processes.

***Hecalus paraumballaensis* Ramasubbarao and Ramakrishnan (Fig. 9)**

Synonym : *Hecalus morrisoni* Rao and Ramakrishnan

Stramineous, Vertex with creamy coloured anterior margin and fore wings straminaceous with a black spot at the end of clavus.

Aedeagus long, narrow with some serrations on both sides of shaft below the apex, a pair of leaf like apical processes directed cephalad, margin serrated, dorsal apodemes finger like and gonopore apical.

***Balclutha pararubrostriata***

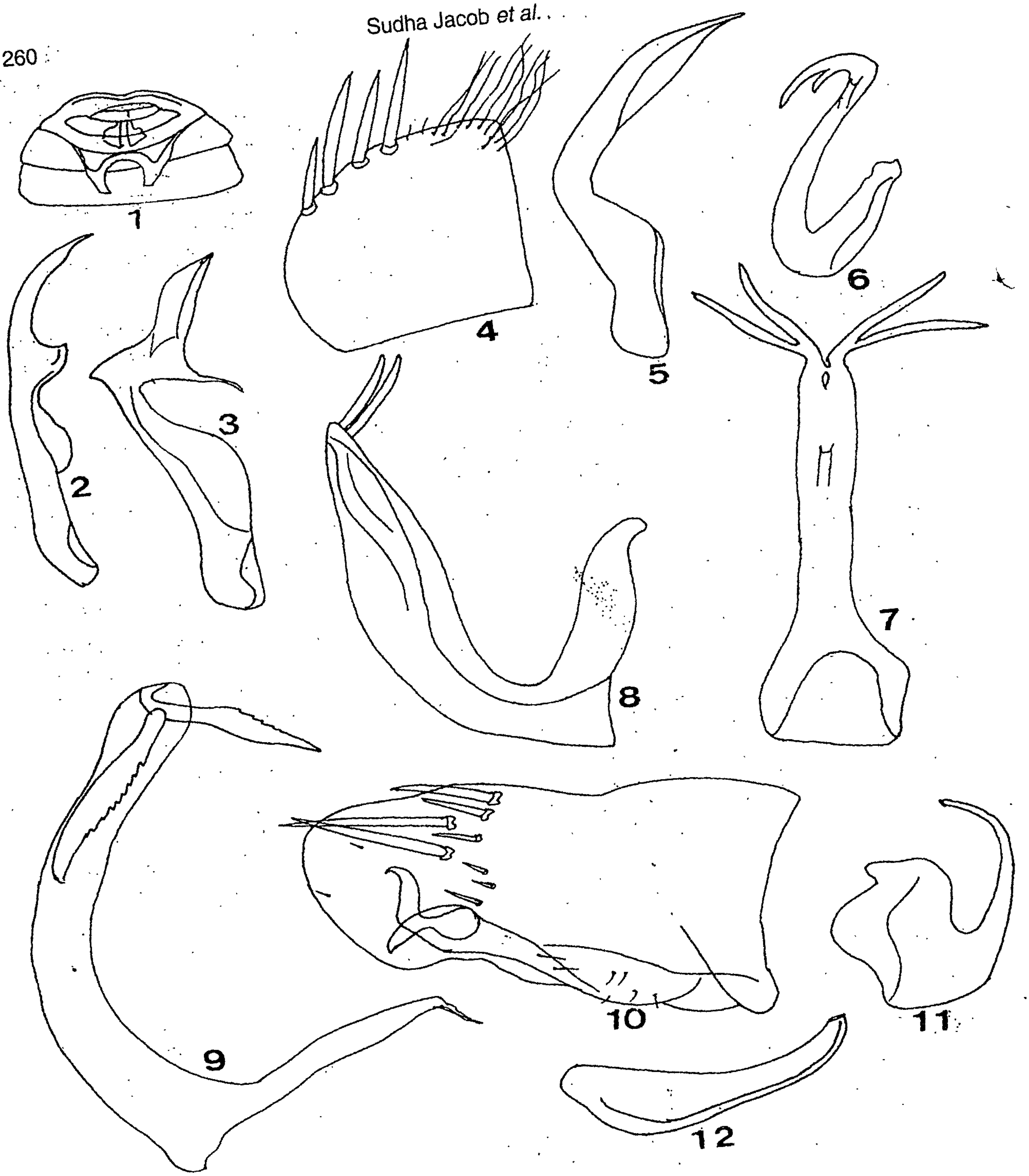
Ramasubbarao and Ramakrishnan (Figs. 10 & 11)

Cream or light yellowish in colour with light orange longitudinal stripes on the vertex, pronotum and scutellum. Forewings pale cream, clavus and adjacent cells in basal half of the wing with reddish stripes, distal areas of subapical cells and apical area of clavus fuscous.

Pygofer with spine like bifid processes, the dorsal branch of process is smaller, hooked, directed ventrad and the ventral branch longer, recurved, hooked and directed dorsad. Aedeagus very much broader at base than at apex, shaft broadly curved dorsocephalad and gonopore apical.

***Nirvana pallida* Melichar**

Yellowish orange in colour. Vertex longer than pronotum with a median white stripe. Forewings with a black dot near the appex and two oblong brown lines on the coastal margin near apex.



***Chlorotettix versicolor* Pruthi**

Synonym : *Hishimonus versicolor* Ramasubbarao and Ramakrishnan

Yellowish green with whitish maculae and numerous blackspots on forewings and fuscos apically. A pair of shinning opaque spots at the base of vertex.

**Masiripius lugubris (Distant)**

Synomyms : Mahala lugubris Distant
Ziziphoides punctatus Rao
Paltymetopius zizyphi Diabola

Moderately robust leafhoppers, greyish with reddish brown spots densly scattered all over and pronotum with two sangunious linear markings. Frontoclypeus narrowed and more than twice as long as wide.

**Doratulina tolla (Pruthi) (Fig. 12)**

Synonym : Aconura tolla Pruthi

Pale yellowish brown leafhopper. Aedeagus wider at base, shaft very short, slightly curved dorsally with blunt apex and gonopore apical.

## ACKNOWLEDGEMENTS

The senior author is thankful to Acharya N G Ranga Agricultural University for providing the financial assistance.

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(Received on 26-5-2002 and revised on 8-7-2002.)

Figs. 1 & 2 *Dettocephalus* (Recilia) accuminatus Dash and Viraktamath
1. Sternal abdominal apodemes
2. Aedeagus and connective - lateral view

Fig. 3 D. (Recilia) breviculus Dash and Viraktamath
Aedeagus and connective-lateral view

Figs. 4 & 5 D. (Recilia) distinctus (Motschulsky)
4. Subgenital plate; 5. Aedeagus and connective-lateral view

Fig. 6. *Empoascanara maculifrons*, Aedeagus - dorsal view

Fig. 7. *Hecalus arcuatus* (de Motschulsky)
Aedeagus - dorsal view

Fig. 8 *H. ghaurii* Ramasubbarao and Ramakrishnan
Aedeagus - lateral view

Fig. 9. H. paraumballaensis Ramasubbarao and Ramakrishnan
Aedeagus - lateral view

Figs. 10 & 11 *Balclutha parasubrostriata* Ramasubbarao and Ramakrishnan
10. Pygofer - lateral view
11. Aedeagus - lateral view

Fig. 12. *Doratulina tolla* (Pruthi)
Aedeagus - lateral view

The Andhra Agric. J. 49 (3&4) : 262 -263 , 2002

# Incidence and Damage of *Helicoverpa armigera* (Hubner) on Different Chickpea Genotypes

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## ABSTRACT

The studies conducted at Agricultural College farm, Bapatla during *rabi* 1997-98, proved that the chickpea genotypes ICCL 86111 from the medium duration group and ICC 506 from the short duration group were found suitable to Krishna - Godavari zone of Andhra Pradesh by recording less incidence, pod damage and higher yields, while long duration genotypes are found unsuitable.

Chickpea (*Cicer arietiuum* L.) is one of the important pulse crops grown in Andhra Pradesh. The over dependence on chemicals to control gram pod borer, *Helicoverpa armigera* (Hubner) has led to development of resistance to all groups of insecticides (Raja Sekhar *et al.* 1994 and 1996). Therefore an attempt was made to screen different popular genotypes under Krishna - Godavari zone of Andhra Pradesh to identify a better genotype with lower incidence and damage under unprotected conditions.

## MATERIAL AND METHODS

Field experiment was conducted during *rabi* 1997-1998 at Agricultural College Farm, Bapatla, by choosing 16 genotypes belonging to short, medium and long duration under unprotected condition in a Randomised Block Design with three replications (Table).

The larval incidence was assessed at flowering, peak flowering, flowering and pod formation, maximum pod formation, pod maturity and crop maturity stages while pod borer damage was recorded at early pod formation, peak pod formation and crop maturity stages. Observations were recorded from 10 plants in each treatment. Based on the above observations the pest resistance was calculated by using the formula

$$\text{Pest resistance (\%)} = \frac{\text{Pod damage in check - Pod damage in test entry}}{\text{Pod damage in check}}$$

## RESULTS AND DISCUSSION

Among the different short duration genotypes ICCV 7 has recorded the lowest larval incidence of 3.67 larvae / 10 plants followed by ICCL 86102 (4.19 larvae per 10 plants) which were on par with each other. Annigeri, the check variety has recorded the highest larval incidence of 17.77 larvae / 10 plants. Among the medium duration genotypes ICCL 86111 (3.8 larvae / 10 plants) proved to be superior over the check variety K 850 (13.72 larvae / 10 plants). However, in the long duration category, the difference in terms of larval incidence was narrow (Table).

The per cent pod damage was also minimum in ICCV 7 (4.88) followed by ICC 506 (6.00), ICCL 86101 (7.66) and ICCL 86102 (9.11) which were on par with each other. The per cent

Table : Incidence and damage of *Helicoverpa armigera* (Hubner) on different chickpea genotypes.

| Sl. No. | Genotypes | Mean larval incidence / 10 plants* | Mean % pod damage** | % pest resistance | Yield kg ha$^{-1}$ |
|---|---|---|---|---|---|
| A. | Desi / Kabuli short duration | | | | |
| 1. | ICCL 86101 | 6.55 | 7.66 | 81.05 | 1570 |
| 2. | ICCL 86102 | 4.19 | 9.11 | 77.47 | 1583 |
| 3. | ICCL 86104 | 5.33 | 10.33 | 74.45 | 1483 |
| 4. | ICCV 7 | 3.67 | 4.88 | 87.93 | 1463 |
| 5. | ICCV 10 | 13.49 | 27.77 | 31.33 | 1641 |
| 6. | ICCC 93122 | 10.64 | 28.55 | 29.40 | 1106 |
| 7. | ICCC 37 | 12.38 | 36.66 | 9.34 | 1033 |
| 8. | ICCC 4958 | 13.88 | 36.77 | 9.07 | 1373 |
| 9. | ICC 506 | 4.60 | 6.00 | 85.16 | 1887 |
| 10. | ICCV 2 | 12.27 | 29.77 | 26.38 | 1487 |
| 11. | Annigeri (check) | 17.77 | 40.44 | Check | 1540 |
| B. | Desi medium duration | | | | |
| 12. | ICCL 86111 | 3.38 | 8.22 | 69.80 | 2120 |
| 13. | ICCV 95992 | 11.59 | 21.66 | 20.42 | 1240 |
| 14. | K 850 (Check) | 13.72 | 27.22 | Check | 720 |
| C. | Desi/Kabuli long duration | | | | |
| 15. | ICCL 86106 | 10.76 | 20.44 | 21.02 | 750 |
| 16. | L 550 (Check) | 12.10 | 25.88 | Check | 743 |
| | C.V. (%) | 10.97 | 11.64 | | 28.95 |
| | S.Em ± | 0.20 | 1.76 | | 16.43 |
| | C.D. (0.05) | 0.56 | 5.08 | | 47.40 |

* Based on 6 observations; ** Based on 3 observations.

pest resistance results revealed ICCV 7 as the promising genotype with per cent pest resistance of 87.9 followed by ICC 506 (85.1). However, ICCL 86111 has recorded the highest yield of 21.20 kg ha$^{-1}$ among the medium duration group followed by ICC 506 (18.87 kg ha$^{-1}$) which belongs to short duration group (Table). The long duration genotypes performed poorly under Krishna - Godavari zone conditions. Similar results were recorded by Lateef and Sachan (1990) indicating that ICC 506, ICCV 7 and ICCL 86102 had higher level of resistance to *Helicoverpa armigera.*

Bhagwat *et al.* (1995) and Patnaik and Mahapatra (1995) also reported that ICC 506 had the lowest per cent pod damage. The present results are in close conformity with the above findings. Thus, the present study clearly revealed that ICCL 86111 among the medium duration group and ICC 506 among the short duration group as highly promising genotypes in Krishna - Godavari Zone by recording lower pest incidence and damage and higher yields, while all the long duration genotypes are found unsuitable.

## ACKNOWLEDGEMENT

The authors are thankful to ICRISAT, Patancheru for providing different chickpea genotypes used in this study.

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(Received on 21-8-2000 and revised on 29-12-2000.)

The Andhra Agric. J. 49 (3&4) : 264 - 267 , 2002

# Estimation of Soil Salinity at Uppugunduru - ORP Site by Electromagnetic Inductive Technique - A Case Study

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## ABSTRACT

The basic principle of EMI (Electro Magnetic Inductive) technique is that a transmitting source induces circular eddy current loops in the soil, whose magnitude is directly proportional to the conductivity of the soil. Each current loop generates secondary electro magnetic field, which induces a current in the receiver, and the out put voltage of the receiver is linearly related to the depth weighted bulk soil electrical conductivity. The main advantages of this technique are rapidity and non-treatment of sample and samples preparation. EMI investigations were carried out at the ORP site, Uppugunduru of IDNP Center, Bapatla. Results indicated that the bulk soil electrical conductivity (Eca) values, computed from EMI surveys data were compared with those measured by the conventional method (Ece ds/m) to understand the feasibility of EMI - meter for estimating bulk soil values. Predictive equations for estimation of bulk soil EC (termed as ECpr) values were subsequently developed and are to be verified from individual observations. Finally, the spatial and temporal variations of ECpr were studied to have the present status of soil salinity at ORP site.

**Key words :** Soil salinity, EMI, Electrical conductivity (EC) and Electro motive force).

Salinity is one of the major soil problems, which affects the crop yield and consequently the socio - economic conditions of the farming community. Salinity problems occur widely over the Indo-Gangetic plains, black soil region, and areas of Rajasthan and coastal areas in the Indian subcontinent. The secondary salinisation due to rise in water table occurs in almost all canal command areas. In Gujarat alone, about 24 per cent area under canal commands is already salinised (Singh 1992). For proper management of such problems, regular monitoring of soil salinity is necesary. Presently the monitoring of soil salinity is based on traditional methods, the visual salinity assessment enables to detect trends within the growing season, where as the laboratory methods though well developed have a disadvantage for continuous monitoring, which are laborious, and time consuming. Therefore there is a need to develop some rapid and non-destructive methods suitable for direct field use and standardise them for location specificity.

Other approaches like electrical resistivity technique reported by Chandra Sekhar *et al.* (1994) are relatively less precise and require more manpower to execute than the EMI approach. Baerends *et al.* (1990) have reported in the soil salinity survey in Pakistan using this approach.

Taking this in to consideration, the EMI technique for measuring and monitoring of bulk soil electrical conductivity was attempted to evaluate the feasibility on the use of EMI meter (Electro Magnetic Inductive meter) for estimation of bulk soil salinity (Eca).

## MATERIAL AND METHODS

### EMI Instrument principle

Whenever, an alternative current is passed through a loop of wire, a time varying magnetic field is generated around it. If another conductor is placed in the field of this current carrying device, an electromotive force is induced in to the conductor. Here, the transmitting source (primary coil) induces an electromotive force (emf) in to the soil, which acts as a conductor. This introduces a secondary electromagnetic field in the soil, which in turn induces a current in the receiver coil. The magnitude of this induced current is directly proportional to the conductivity of the soil. The primary electro magnetic field of the transmitter also induces directly a current in the receiver coil, which is nulled by an appropriate feed value circuit in the system. The out put voltage is linearly related to the depth weighted ECa which is displaced on a Liquid Crystal Detector (LCD).

### Field investigations

Fifty eight locations were selected of gird size 60 X 60 m in 21 ha area where in the EMI readings were taken at Uppugunduru ORP site of IDNP. From each location five readings were taken to each vertical and horizontal readings and mean of these readings were taken. Horizontal reading was taken keeping the instrument on the ground at horizontal position with its coil parallel to the surface (termed as EMh) and vertical reading was taken by keeping the instrument at vertical position with its coil perpendicular to the soil surface (termed as EMv). EMh & EMv were used to calculate the ECa by equations given by Rhoades *et al.* (1989 a) for different depths content at different locations having the same ECa values were considered. It was observed that for a particular ECe, ECa values were lower.

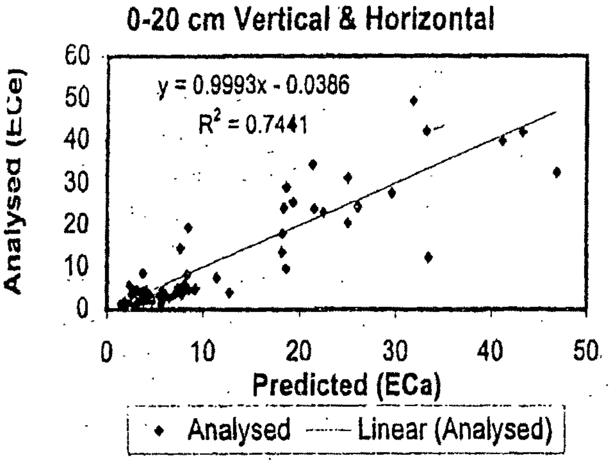
### Development of Predictive equations

The regression equations developed by Rhoades *et al.* (1989 b) which were used for ECa computation were established on the basis of experiments conducted with respect to the present study. Further, those equations were obtained on the basis of four electrode probe, which is self needs proper location specific. Keeping this in view in the present study, an attempt has been made to develop new regression equations using EMI data and soil electrical conductivity (ECe) values determined by conventional method.

## RESULTS AND DISCUSSION

Using the regression equations given by Rhoades *et al.* (1989 b) ECa values for each location were calculated for composite and discrete depth (0-20, 20-50 and 50-120) up to 1.20 m in the soil profile from ground level. A positive and significant correlation existing between ECa and ECe values and revealed that the instrument can be used as an alternative for the conventional methods. The ECa values for composite depth as well as discrete depths were positively correlated and it is found that the equations with both horizontal and vertical readings are more correlated than horizontal or vertical alone (Table 1). The distribution of both ECe and EC pr (Electrical conductivity calculated by using the predictive equations) when plotted with 1:1 line for all depth intervals show that EC pr values are relatively closer to the 1:1 line and ECe values (Fig. 1).

The study revealed that the soil salinity values determined by the rapid method of EMI technique showed a positive and significant correlation with the conventional method. Predictive equations were developed based on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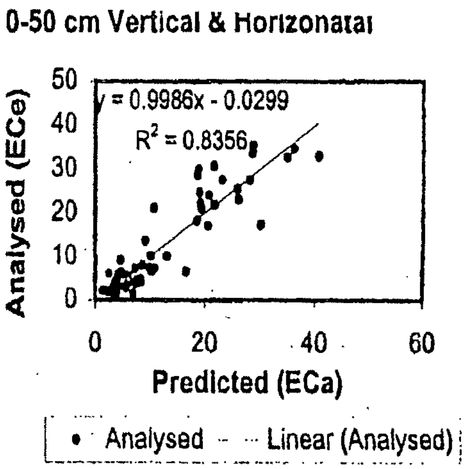
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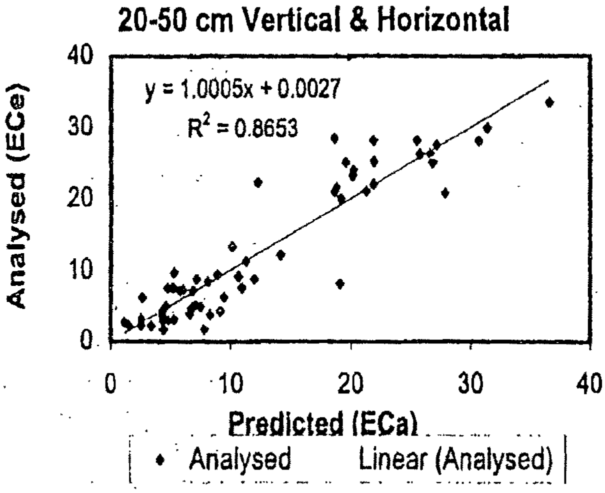
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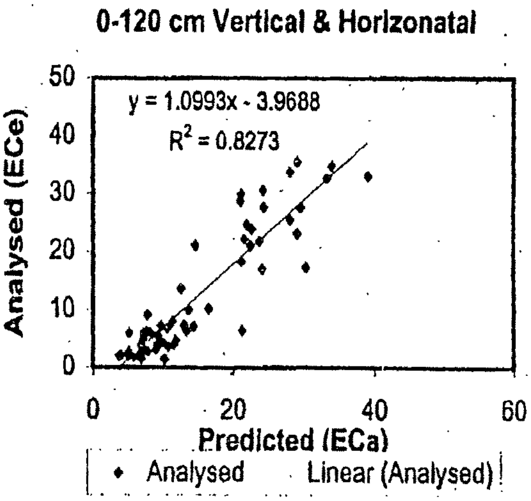
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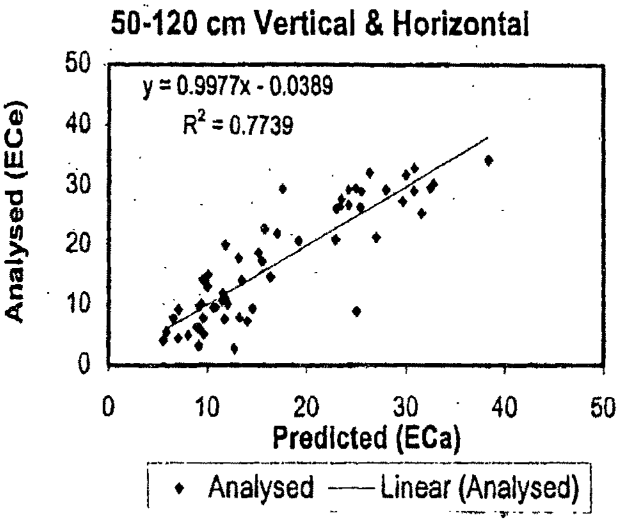
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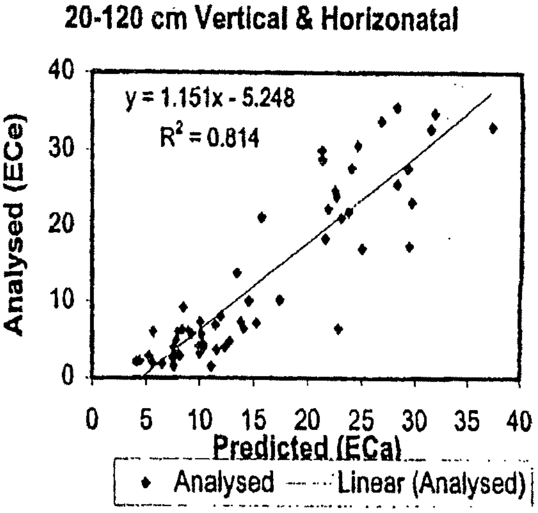
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Table. Prediction equations for estimation of EC based on EM - 38 data, Uppugunduru ORP site.

| S.No. | Depth (m) | Prediction Equations | Std. Error | Multiple R | Multiple $r^2$ |
|---|---|---|---|---|---|
| 1 | 0.0 - 0.20 | ECa = -0.068 X EMv + 0.139 X EMh + 0.795 | 6.93 | 0.86 | 0.74 |
| 2 | 0.20 - 0.50 | ECa = 0.0053 X EMv + 0.0489 X EMh - 4.16 | 3.67 | 0.93 | 0.87 |
| 3 | 0.50 - 1.20 | ECa = 0.023 X EMv + 0.027 X EMh - 0.948 | 4.73 | 0.88 | 0.77 |
| 4 | 0.0 - 0.50 | ECa = -0.0241 X EMv + 0.085 X EMh - 2.117 | 4.54 | 0.91 | 0.84 |
| 5 | 0.0 - 1.20 | ECa = -0.00315 X EMv + 0.0513 X EMh - 1.46 | 4.15 | 0.91 | 0.83 |
| 6 | 0.20 - 1.20 | ECa = 0.0174 X EMv + 0.0337 X EMh - 1.91 | 4.18 | 0.90 | 0.82 |

the EMI survey data, among these EMh & EMv equations are to be tested further for wider applicability.

## ACKNOWLEDGEMENT

The authors are highly thankful to International Land Reclamation Institute, Wageningen, The Netherlands for providing funds to carryout the Research work through IDNP, Bapatla. The work carried out by Saline Water Scheme, Bapatla as a Co-opted center of Indo - Dutch Net Work project, Bapatla.

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(Received on 26-4-2002 and revised on 20-6-2002.)

The Andhra Agric. J. 49 (3&4) :268-270, 2002

# Productivity and Quality of Greengram as Influenced by Sulphur Application During *Kharif* Under Rainfed Conditions

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## ABSTRACT

Results of a field experiment conducted during rainy seasons of 1996 and 1997, to study the effect of Sulphur application in the form of gypsum and its mode of application showed that 20 kg s $ha^{-1}$ (half basal and half as side dressing at 25 DAS) significantly increased the grain yield of greengram as well as protein content of grain; and further increase in Sulphur dose decreased the grain yield. The maximum protein content was recorded with higher level of 40 kg s $ha^{-1}$ but wa statistically at par with lower level of 20 kg s $ha^{-1}$ under rainfed conditions.

The recent reports show that high yields of any crop can not be sustained by using only NPK. Other nutrients particularly Sulphur have to be integrated into the balanced fertilization plan as and when their defficiencies start limiting optimal crop production and yield responses become economical. Further, the role of Sulphur in plants, particularly with respect to the synthesis of proteins in grain legumes besides increasing grain yields, forced the research workers to concentrate on Suphur application. Sulphur nutrition in relation to greengram is rare as the crop is grown by marginal farmers, more so in vertisols of Andhra Pradesh under rainfed conditions, where the aspect has remained untouched so far. Hence, the present study was conducted to study the response of greengram which is cultivated under rainfed condition during *kharif*, to different levels of Sulphur and mode of its application.

## MATERIAL AND METHODS

Field experiments were conducted during *Kharif* seasons of 1996 and 1997 at Regional Agricultural Research Station, Lam (A.P.). The experimental field was vertisol with clayey in texture, having pH 8-2, organic carbon 0.25% available $P_2O_5$ 15 kg $ha^{-1}$ available $K_2O$ 425 kg $ha^{-1}$ and available Sulphur 23 kg $ha^{-1}$. The experiment consisted of three levels of Sulphur (0, 20 and 40 kg $ha^{-1}$) and three modes of Sulphur application i.e., full basal, full side dressing at 25 days after sowing, and half basal and half side dressing at 25 DAS. The treatments were laid out in Randomised Block Design with four replications. The rains received during the crop season were 604.7 mm with 26 rainy days in 1996 and 438.2 mm with 24 rainy days in 1997. A recommended dose of 20 kg N and 50 kg $P_2O_5$ $ha^{-1}$ was applied to the crop as basal dose. Gypsum was used as a source of Sulphur and

Table : Productivity and quality of greengram as influenced by Sulphur application under rainfed condition.

| Treatments | Plant height (cm) | | No. of pods plant$^{-1}$ | | 100 seed weight (g) | | Grain yield (kg ha$^{-1}$) | | Protein content (%) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ |
| $T_1$ - Control | 49.6 | 38.0 | 15 | 15 | 2.82 | 2.79 | 381 | 376 | 20.2 | 20.0 |
| $T_2$ - 20 kg S ha$^{-1}$ as basal | 53.0 | 41.9 | 16 | 18 | 2.86 | 2.83 | 400 | 428 | 21.3 | 21.9 |
| $T_3$ - 20 kg S ha$^{-1}$ as side dressing at 25 DAS | 53.3 | 42.5 | 23 | 22 | 2.94 | 2.88 | 672 | 560 | 22.1 | 22.8 |
| $T_4$ - 10 kg S ha$^{-1}$ as basal and 10 kg S ha$^{-1}$ as side dressing at 25 DAS | 53.9 | 43.0 | 25 | 23 | 2.99 | 2.90 | 764 | 635 | 23.0 | 23.6 |
| $T_5$ - 40 kg S ha$^{-1}$ as basal | 54.1 | 44.1 | 21 | 22 | 2.88 | 2.84 | 641 | 572 | 23.5 | 23.8 |
| $T_6$ - 40 kg S ha$^{-1}$ as side dressing at 25 DAS | 54.6 | 44.8 | 19 | 20 | 2.85 | 2.78 | 626 | 557 | 23.8 | 24.0 |
| $T_7$ - 20 kg S ha$^{-1}$ as basal and 20 kg S ha$^{-1}$ as side dressing at 25 DAS | 55.6 | 45.6 | 18 | 21 | 2.89 | 2.89 | 622 | 570 | 23.6 | 23.9 |
| C.D. (P=0.5) | NS | NS | 2.6 | 3.0 | NS | NS | 7.05 | 84.97 | 2.3 | 2.5 |

$Y_1$ - 1996, $Y_2$-1997.

applied as per treatments. The seeds of LGG 460 cultivar were sown on 10th July in 1996 and 26th July in 1997 at 30 x 10 cm spacing and the crop was harvested on physiological maturity. The grain samples were analysed for total nitrogen by microkejldahl method and protein content was calculated by multiplying N content by the factor 6.25.

## RESULTS AND DISCUSSION

The data regarding the plant height and seed index show that the application of Sulphur in the form of gypsum had no effect on the plant height and seed index during both the years. However, there was significant increase in number of pods/plant on application of Sulphur but the decline in number of pods was noticed beyond 20 kg S ha$^{-1}$, which was clearly evidented by grain (Table 1).

Application of 20 kg S ha$^{-1}$ (half as basal and half as side dressing at 25 DAS) recorded the maximum grain yield during both the years. Similar findings were reported by Mehta and Singh (1979) and Naphade and Wankhede (1987). The efficiency of Sulphur as far as mode of application was in the order of Basal plus side dressing - side dressing - basal alone at lower level (20 kg S ha$^{-1}$) of sulphur but the similar trend was not noticed at higher level of 40 kg S ha$^{-1}$. Split application of Sulphur (half as basal and half at 30 days after sowing) was also suggested by Chitkala Devi *et al.* (1987). Such findings obviously reflect the combined advantage of providing Ca and S during flowering and grain filling in legumes. The grain yield was significantly decreased at higher level (40 kg S ha$^{-1}$) as compared to lower level of 20 kg S ha$^{-1}$ in split ($T_4$) in 1996 but were statistically at par in 1997. The results are in accordance with the reports of Lal and Jaiswal (1981), who reported that 30 kg S ha$^{-1}$ (as gypsum) increased seed yield of urd; further increased in Sulphur dose decreased the grain yield.

The protein content of grain increased on application of Sulphur but the significant increase was recorded with ($T_4$) 20 kg S $ha^{-1}$ (half basal and half at 25 DAS) and with all modes of application at higher lelvel of 40 kg S $ha^{-1}$ in 1996, whereas in 1997, the significant increase in protein content was also recorded with 20 kg S $ha^{-1}$ as side dressing at 25 DAS ($T_3$). The maximum protein content was recorded with higher level (20 kg S $ha^{-1}$) during both the years. The results are in conformity with the reports of Kamat *et al.* (1981).

Therefore, it was concluded that the application of 20 kg S $ha^{-1}$ (half as basal and half as side dressing at 25 DAS) is must for achieving higher productivity and quality of greengram in vertisols of Andhra Pradesh under rainfed conditions.

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(Received on 26-4-2002 and revised on 19-6-2002.)

The Andhra Agric. J. 49 (3&4) : 271 - 273, 2002

# Efficiency and Economics of Weed Management in *Kharif* Blackgram

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## ABSTRACT

A field experiment conducted on a clay soil during *Kharif* 2000 to study the efficiency of different weed control treatments and found that the early post emergency application of imazethapyr @ 0.1 Kg a.i ha$^{-1}$ and two hand weedings at 20 and 40 DAS gave significantly higher yields compared to un-weeded control. But the net returns and benefit - cost ratio were lower with these treatments due to higher cost of treatments. The maximum benefit - cost ratio of 8.46 was obtained with fluchloralin @ 1.0 Kg a.i. ha$^{-1}$.

**Key Words** : Black gram, Weed management, Soil solarization

Blackgram in Andhra Pradesh is grown in an area of 4.30 lakh hectares producing 2.62 lakh tonnes with an average productivity of 60.9 Kg ha$^{-1}$. (Economics and Statistical Bulletin, 1999). Of the several factors responsible for its low productivity, weed infestation is the major one as it causes around 50 per cent reduction in yield (Vat and Sawhney, 1981). It is imperative to control weeds in time with right dose of herbicides that could restore high yield potential of the crop. Apart from Chemical and Physical methods of weed control, soil solarization a new disinfestation method to control soil borne pathogens and weeds, is also gaining importance. Soil solarization is comparatively cheep, easy and eco-friendly weed control technology and can be employed in Agriculture with success.

## MATERIAL AND METHODS

A field experiment conducted at the Agricultural College Farm, Bapatla during *kharif* 2000 on a clay soil, laid - out in Randomized Block Design with nine treatments replicated four times. The test variety was LBG-20 sown on 27-7-2000 spaced at 30 x 10 cm. The plots with solarization treatments were ploughed, irrigated to saturation and then covered with polyethylene sheets of 0.05 mm and 0.1 mm thickness as per the treatments, which were removed after 30 days. No weeding was followed in the solarized plots thereafter. Soil temperature from 5 cm depth was recorded at weekly interval both for the solarized treatment plots as well as control plots using soil thermometers. The crop was harvested on 11-10-2000.

### Treatment details

$T_1$ Control (Un weeded check)
$T_2$ Weed free (Weed free conditions maintained by hand weedings at weekly interval up to 60 DAS).
$T_3$ Soil solarization with 0.5 mm thick transparent polyethylene sheet.
$T_4$ Soil solarization with 0.1 mm thick transparent polyethlene sheet.
$T_5$ Hand weeding at 20 DAS
$T_6$ Hand weeding at 20 and 40 DAS.
$T_7$ Benthiocarb @ 0.5 Kg a.i.ha$^{-1}$ (Pre-emergence application)
$T_8$ Fluchloralin @ 1.0 Kg a.i. ha$^{-1}$ (Pre-planting Incorporation)
$T_9$ Imazethapyr @ 0.1 Kg a.i. ha$^{-1}$ (early post emergence application)

Table 1 : Efficiency and economics of weed control treatment in *kharif* blackgram.

| Treatments | Weed population (No m$^{-2}$) | Weed drymatter (gm$^{-2}$) | WCE (%) | Seed Yield (kg ha$^{-1}$) | Net returns (Rs.) | BCR |
|---|---|---|---|---|---|---|
| $T_1$ | 16.62*<br>(276.0) | 62.5 | - | 564 | - | - |
| $T_2$ | 4.94<br>(24.0) | 11.6 | 98.00 | 1332 | 8301.0 | 1.24 |
| $T_3$ | 12.74<br>(162.0) | 37.8 | 65.0 | 834 | -14989-0 | -0.74 |
| $T_4$ | 14.01 | 38.6 | 61.0 | 802 | -15613.0 | -0.77 |
| $T_5$ | 10.6<br>(140.0) | 38.2 | 60.0 | 940 | 5997.0 | 4.49 |
| $T_6$ | 6.36<br>(40.0) | 32.2 | 93.0 | 1222 | 10606.0 | 4.76 |
| $T_7$ | 14.94<br>(223.0) | 39.8 | 56.0 | 720 | 2717.35 | 8.37 |
| $T_8$ | 11.76<br>(138.0) | 37.0 | 68.0 | 1076 | 8929.35 | 8.46 |
| $T_9$ | 11.20<br>(125.0) | 36.1 | 72.0 | 1210 | 10997.0 | 6.87 |
| SEm± | 0.46 | 1.22 | 0.9 | 33.5 | | |
| CD (P=0.05) | 1.26 | 2.56 | 2.7 | 97.8 | | |

Figures in parantheses indicate original values

*$\sqrt{X+0.5}$ tranformed valued

Cost of inputs
Benthiocarb - Rs. 260 per litre
Imazethapyr - Rs. 1600 per litre
Fluchloralin - Rs. 470 per litre

WCE - Weed Control Efficiency
BCR - Benefit - Cost ratio
Cost of outputs
Cost of blackgram - Rs. 1950 quintal$^{-1}$
Cost of polyethylene sheet (100m$^2$)
Rs. 600.62 per three seasons.

## RESULTS AND DISCUSSION

### Weed flora

The dominant weed flora observed in blackgram were *Cyperus rotundas, Cyanodon dactylon, Digitaria sanguinalis, phyllanthus firuri, phyllanthus madraspatanensis, Commelin benghalensis. Trianthema portulocastrum* etc.

### Weed population and biomass

The weed density was lower with weed free treatment (24.0 m$^{-2}$) followed by two hand weedings at 20 and 40 DAS. (40.0 m$^{-2}$). The treatments $T_5$, $T_8$ and $T_9$ were statistically comparable which is attributed to the better spread of the crop canopy there by restricting the light interception by weeds. Significant influence of soil solarization was observed with different thickness of transparent polyethylene sheets on the total dry matter accumulation of weeds. Soil solarization with transparent polyethylene sheet ($T_3$) was superior over thicker transparent polyethylene sheet ($T_4$) treatment. This might be due to reduced weed density in these treatments. Lowest (18.92 gm$^{-2}$) dry matter accumulation was associated with $T_6$ treatment followed by $T_9$ (31.27 m$^{-2}$). Reduced weed dry weight with the application of Imazethapyr in soybean was also reported earlier by Bilore *et al.* (1998).

### Weed Control Efficiency

Among the herbicides the maximum weed control efficiency was observed with

Table 2 : Influence of soil solarization treatments on soil temperature (°C) at 5 cm depth of soil at weekly intervals.

| Treatments | Soil Temperature (°C) | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Control | 34.0 | 33.6 | 31.7 | 31.5 |
| Soil solarization with 0.05 mm thick TPS | 46.7 | 43.7 | 43.2 | 41.0 |
| Soil solarization with 0.1 mm thick TPS | 39.5 | 38.1 | 37.8 | 36.7 |

TPS -- Transparent polyethylene sheet.

imazeythapyr @ 0.1 Kg a.i. $ha^{-1}$ (72.0%) followed by fluchloralin @ 1.0 Kg a.i. $ha^{-1}$ (68%). The highest weed control efficiency of 93.0 per cent was recorded with hand weeding twice at 20 and 40 DAS. $T_3$ and $T_4$ treatments recorded weed control efficiency of 65.00 and 61.00 per cent respectively. Soil solarization with transparent polyethlene sheets offered superior weed free environment to blackgram providing an opportunity to grow under less competitive situations. These results are in conformity with the findings of Patel *et al.* (1980) in tobacco and Katan (1984) in cotton.

## Blackgram Seed Yield

Significantly increased seed yield of 1222 Kg $ha^{-1}$ was recorded with two hand weedings at 20 and 40 DAS which was comparable with early post - emergence treatment of imazethapyr @ 0.1 Kg a.i. $ha^{-1}$. While Pre-plant incorporation of fluchloralin @ 1.0 Kg a.i. $ha^{1}$ recorded 1076 Kg $ha^{-1}$, $T_3$ and $T_4$ recorded 47.8 per cent and 42.1 per cent increased seed yield over un weeded check respectively.

## Economics

The maximum net income of Rs. 10,997 was obtained with early post - emergence application of imazethapyr @ 0.1 Kg a.i. $ha^{-1}$($T_9$) among the herbicidal treatments over no weeding ($T_1$). However, negative returns were associated with the two solarization treatments $T_3$ and $T_4$ which can be attributed to the higher initial cost incurred on the polyethylene sheet. The maximum benefit-cost ratio of 8.46 was recorded with fluchloralin @ 1.0 Kg a.i. $ha^{-1}$. Though the two hand weedings $T_6$ and imazethapyr treatments were instrumental in recording maximum yield and net retruns over all the other treatments, their benefit-cost ratio was only 4.76 and 6.87 respectively. The lower benefit - cost ratio in these treatments was mainly due to higher cost involved in manual weeding and imazethapyr herbicide. On considering economics, pre-plant incorporation of fluchloralin @ 1.0 Kg a.i. $ha^{-1}$ was found to be the most cost affective practice of managing the weeds in *Kharif* blackgram.

## Soil Temperature

Higher soil temperatures were recorded with soil solarization with 0.05 mm thick transparent polyethylene sheet (46.7°C) in the first week over the other solarization treatment ($T_4$) (Table 2). The thinner transparent polyethylene is comparatively superior to the thicker transparent polyethylene sheet owing to its higher radiation transmittance. These findings agree with Lodha *et al.* (1991) and Enand (1991).

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(Received on 10-12-2001 and revised on 13-2-2002.)

The Andhra Agric. J. 49 (3&4) : 274 - 276, 2002

# Efficacy of Herbicides and Herbicide Mixtures for Weed Control in Direct Seeded Low Land Rice

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## ABSTRACT

Results of field experiment conducted at Agricultural College Farm, Bapatla during *Kharif*, 1999 revealed that hand weeding at 20 and 40 DAS was effective in reducing the density and Drymatter production of total weeds and in improving the weed control efficiency and rice yields. Aplication of thiobencarb + 2, 4- DEE superior when compared to other treatments. Among the herbicide treatments, herbicide combinations were more efficient in significantly reducing the weed densities and drymatter production of weeds, compared, to the herbicides applied alone. Hand weeding and oxadiazon + 2,4 - DEE combination significantly reduced the weed competition and improved the grain yield of rice (4531 and 4500 Kg ha$^{-1}$ respectively) by 45 and 44 per cent over unweeded check (3115 Kg ha$^{-1}$).

**Key words :** Herbicides, Weed Control, Low Land Rice, Morphological Characters.

Yield losses due to weed competition are reported upto 11 per cent in transplanted rice, and 20 and 46 per cent in direct seeded wet and dry rice respectively in India (De Datta, 1979). Weed competition is greater in wet seeded rice than in transplanted rice, because of synchronous emergence, similarities in age and morphological charcterstics of grassy weeds and rice seedlings (Moody, 1983). Sharma *et al.* (1977) reported in direct sown rice for getting economical yield. Since hand weeding is difficult under direct seeded condition, pre emergence herbicides may play an important role in the early weed control. Most of the herbicides when applied alone may not have wide spectrum weed control efficiency. Keeping this in view, the present study was carried out to evaluate the efficiency of different herbicides and their combination with 2,4-DEE in controlling weeds in direct seeded low land rice.

## METERIAL AND METHODS

A field investigation was carried out at the Agricultural College Farm, Bapatla during *Kharif*, 1999. The treatments (Table 1) along with manual method of hand weeding done at 20 and 40 DAS and two checks, viz., weed free and unweeded checks. All the herbicides were applied on seventh day after sowing. The experiment was laid out in a Randomised Block Design with three replications. The soil was a sandy clay loam with a pH of 8.4, low in available nitrogen (215 kg ha$^{-1}$) and available phosphorus (16.2 kg ha$^{-1}$) and high in available potassium (435 kg ha$^{-1}$). Rainfall during the crop growth was 538.7 mm.

The field was thoroughly prepared and puddled. Initially the water was drained off the plots and pre-germinated seeds of rice Cv. Chaitanya were broadcast uniformly adopted 80 kg ha$^{-1}$ seed rate. Crop was fertilized with 40 kg N, 60 kg $P_2O_5$ and 40 kg $K_2O$ per hectare. The

Table: Effect of weed control treatments on weed densities, dry weghts and grain yield of rice.

| | Treatments | Sedges | Grasses | Broad leaf weeds | Total weed population | Total weed dryweight (kg ha$^{-1}$) | WCE (%) | WI (%) | Grain yield (kg ha$^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | Butachlor @ 2.0 Kg a.i. ha$^{-1}$ | 4.29<br>(18.00) | 2.91<br>(8.00) | 2.95<br>(8.23) | 5.90<br>(34.33) | 23.23<br>(540.00) | 27.5<br>(21.7) | 27.3<br>(21.6) | 3850 |
| $T_2$ | Butachlor + 2,4-DEE @ 1.5 Kg a.i + 0.4 Kg a.i. ha$^{-1}$ | 3.52<br>(12.00) | 2.54<br>(6.00) | 2.77<br>(7.33) | 5.08<br>(25.33) | 18.20<br>(331.00) | 45.8<br>(51.4) | 18.6<br>(10.7) | 4396 |
| $T_3$ | Pretilachlor @ 1.0 Kg a.i. ha$^{-1}$ | 3.89<br>(14.66) | 2.54<br>(6.00) | 2.12<br>(4.00) | 5.01<br>(24.66) | 19.08<br>(364.00) | 43.0<br>(46.5) | 31.6<br>(28.7) | 3487 |
| $T_4$ | Pretiachlor + 2,4-DEE @ 0.75 Kg a.i. + 0.4 Kg a.i. ha$^{-1}$ | 3.13<br>(9.33) | 2.41<br>(5.33) | 1.87<br>(3.00) | 4.26<br>(17.66) | 18.14<br>(326.00) | 45.3<br>(50.6) | 25.9<br>(19.5) | 3950 |
| $T_5$ | Oxadiazon @ 0.5 Kg a.i. ha$^{-1}$ | 3.89<br>(14.66) | 2.91<br>(8.00) | 2.11<br>(4.00) | 5.21<br>(26.66) | 19.88<br>(395.00) | 40.4<br>(42.0) | 24.6<br>(17.7) | 4042 |
| $T_6$ | Oxadiazon + 2,4-DEE @ 0.3 Kg a.i. + 0.4 Kg a.i. ha$^{-1}$ | 3.34<br>(10.66) | 2.11<br>(4.00) | 1.73<br>(2.66) | 4.22<br>(17.33) | 17.89<br>(320.00) | 46.7<br>(53.0) | 15.9<br>(8.5) | 4500 |
| $T_7$ | Thiobencarb @ 2.0 Kg a.i. ha$^{-1}$ | 3.27<br>(10.33) | 2.16<br>(4.33) | 2.11<br>(4.00) | 4.37<br>(18.66) | 17.42<br>(303.00) | 48.1<br>(55.5) | 36.0<br>(34.7) | 3200 |
| $T_8$ | Thiobencarb + 2,4 - DEE at @ 1.5 kg a.i. + 0.4 Kg a.i. ha$^{-1}$ | 2.91<br>(8.00) | 2.48<br>(5.66) | 1.26<br>(1.33) | 3.93<br>(15.00) | 17.07<br>(291.00) | 49.0<br>(57.0) | 28.1<br>(22.2) | 3837 |
| $T_9$ | Hand weeding at 20 and 40 DAS | 2.11<br>(4.00) | 1.34<br>(1.33) | 2.11<br>(4.00) | 3.13<br>(9.33) | 14.59<br>(213.00) | 56.0<br>(68.7) | 15.9<br>(7.9) | 4531 |
| $T_{10}$ | Weed free check | 0.70<br>(0.00) | 0.70<br>(0.00) | 0.70<br>(0.00) | 0.70<br>(0.00) | 0.70<br>(0.00) | 90.0<br>(100.0) | 4.0<br>(0.0) | 4938 |
| $T_{11}$ | Unweedy check (control) | 4.63<br>(21.00) | 2.95<br>(8.33) | 3.86<br>(14.66) | 6.66<br>(44.00) | 26.12<br>(628.00) | 4.0<br>(0.0) | 37.0<br>(36.9) | 3115 |
| | SEm± | 0.11 | 0.14 | 0.25 | 0.10 | 0.23 | 0.9 | 2.2 | 176.6 |
| | CD (0.05) | 0.34 | 0.44 | 0.74 | 0.29 | 0.68 | 2.7 | 6.5 | 521 |
| | CV % | 6.22 | 10.79 | 20.34 | 3.96 | 2.30 | 3.5 | 16.1 | 7.7 |

The figures in the paranthesis are original values basal dose and other 80 kg N was applied into two splits viz., at active tillering and panicle initiation stages. Zinc sulphate @ 50 kg ha$^{-1}$ was also applied at the time of puddling. Herbicides were applied to the designated plots as per treatments by mixing with sand @ 50 kg ha$^{-1}$. Periodical weed densities and dry weights of weeds and rice grain yield were recorded (Table 1).

## RESULTS AND DISCUSSION

The experiment plots were dominated with sedges at 48 per cent followed by 33 per cent of broad leaf weeds. Grassy weeds constituted only 19 per cent of the total weed population. *Cyperus rotundus, Fimbristylis miliaceae* among sedges, *Echinochloa colonum, Cynotis axillaris, Leersia hexandra, Leptochloa chinensis, Cynodon dactylon* among grasses and *Eclipta alba, Ludwigia parviflora, Ammania baccifera* among broad leaf weeds were the important weed species. There was significant reduction in the densities of all group of weeds as against in weedy check at maturity stage. Weed control treatments recorded 30 - 62 per cent control in sedges, 4-84 per cent in grasses and 50 to 91 per cent in broad leaf weeds, while, thiobencarb in combination with 2,4 DEE recorded the highest total weed control, it recorded the lowest and significantly lower total weed dry matter among the herbicide treatments, but remained superior to the two manual weedings.

All the herbicidal treatments significantly reduced the weed population, weed dryweight weed index value and improved the weed control efficiency, besides increased the grain yield of rice compared to unweeded check. Among the treatments hand weeding twice at 20 and 40 DAS, was the most effective in minimizing the weed composition compared to the other treatments.

Among the herbicide treatments, herbicidal combination with 2,4 -DEE were efficient than the herbicides applied alone in recording lower weed densities (15.00 to 25.33 m$^{-2}$) and weed dry weights (291 to 331 kg ha$^{-1}$). This can be attributed to the broad spectrum activity of the herbicide combinations on multiple weed groups and thus registered higher weed control efficiencies (50.6 to 57.0%) compared to herbicides applied alone (21.7 to 55.5%) . Among all the herbicide treatments, thiobencarb + 2,4 - DEE (1.5 kg a.i. + 0.4 kg a.i. ha$^{-1}$) effectively suppressed the sedges, grasses and broad leaf weeds (8.00, 5.66 and 1.33 m$^{-2}$, respectively) as compared to unweeded check (21.00, 8.33 and 14.66 m$^{-2}$, respectively). while, all the other herbicides were effective in controlling grass population.

Lower weed density (15.00 m$^{-2}$), drymatter accumulation by weeds (291 kg ha$^{-1}$), maximum weed control efficiency (57.0%) were recorded under thiobencarb+2,4 -DEE treatment. Though thiobencarb and pretilachlor alone recorded superior weed control efficiency, the initial crop injury caused by these herbicides resulted in poor crop growth resulting in poor yield and higher weed index values. Phytotoxicity to crop in the initial stages and persistent effect at later stages leading to higher yield losses was reported with thiobencarb (Ali *et al.*, 1987, Ooi, 1988 and Gogoi and Sharma, 1994) and also with pretilachlor (Moorthy, 1997).

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(Received on 17-12-2000 and revised on 20-3-2001.)

The Andhra Agric. J. 49 (3&4) : 277 - 279, 2002

# Effect of Deficiency of Macro Nutrients on Growth Pattern of Tomato (*Lycopersicon esculentum.* Mill)

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## ABSTRACT

Deficiency symptoms of macronutrients, viz., N,P,K,Ca, Mg and S were developed and described from a sand culture experiment. Tomato plants grown with deficient nutrients exhibited stunted growth with poor root and shoot development, reduced biomass production in general and leaf chlorosis with or without formation of necrotic spots with specific nutrient dificiencies. Plant growth was severely affected due to the deficiencies of N,P and Ca and marginally affected due to the deficiencies of K, Mg, and S.

Mineral nutrition has been recognized as an important constraint in crop production particularly in case of major vegetable crops. Tomato is the important vegetable crop extensively grown in the local tracts of Krishna - Godavari zone of Andhra Pradesh. In these crops maintaining adequate quantities of plant nutrients either in soil or growing media is important. N,P and K are required in large amounts, while most of the remaining nutrients are needed in only small amounts, where there is a deficiency, the plant shows the deficiency symptoms. Such deficiency symptoms are noticed particularly in light textured sandy and calcareous soils or in green house where unhumified organic matter is used. The soil types in the tomato growing tract around Bapatla comprises of poor sandy soil, which may possibly result in the exhibition of nutritional disorders expressed through visible and measurable foliar and structural symptoms. Comprehensive work in this field of study was not carried out earlier in tomato. Therefore, it is felt necessary to undertake a study on the development and description of nutrient deficiencies in tomato.

## MATERIAL AND METHODS

A sand culture experiment was conducted in the Department of Horticulture, Agricultural College, Bapatla during 2000, using tomato cultivar Arka Vikas. The seeds were sown directly in polythene bags containing washed river sand. Seedlings were grown for a period of 15 days ( 3 leaf stage) by giving double distilled water. Later they were given nutrient solutions. The polythene bags were provided with basal drainage holes and the sides were covered with brown paper to prevent the entry of sunlight, which could allow the algal growth. The treatments imposed were -N, -P, -K, -Ca, -Mg and -S which denote the omission of corresponding element from the complete nutrient solution and a control for comparison. Solutions with deficiency of these elements were prepared with double distilled water. The stock solution prepared as per the modified Hoagland's formulation (Johnson *et al*, 1987). Initially the seedlings were given with nutrient solution at half the strength, which was increased to full strength after one week. The seedlings in the bags received respective nutrient solutions once in three days and they were grown up to 53 DAS and the sequential development of nutrient deficiencies were keenly observed and thoroughly described. Biometric data on plant height, leaf number, leaf area and dry weight of plant were recorded on per plant basis and compared with that of control seedlings supplied with complete nutrient solutions.

## RESULTS AND DISCUSSION

The tomato seedlings grown with different nutritional deficiencies, in general, showed stunted growth as evidenced from poor root and shoot development and production of reduced amount of biomass (Table).

### Nitrogen

Seedlings starved of N started the chronological display of symptoms of deficiency from the first week after starting of giving nutrient solutions. Growth almost ceased after second week onwards. Seedlings were scarcely branched and highly stunted (71.61% reduction in height) with reduced internodal length and their stems. Leaves were reduced in number and area recording a reduction of 61.30 and 91.07 per cent respectively over control. Yellowing was initially noticed on the mature leaves and later in the younger leaves supporting the concept that N is mobile in plant (Mehrotra *et al*, 1968). A meager dry matter accumulation was recorded amounting only 83.03 per cent in that of control had occurred. Growth was almost stopped within 40 DAS and plants failed to initiate new leaves.

### Phosphorus

Symptoms of P deficiency started appearing within 10 days after giving nutrient solutions to the seedlings. Seedlings were reduced in height erect and stiff, leaf number was greatly reduced (95.03% reduction in that of control). The leaves were deep brown to bluish green with reddish violet discolourations along the veins on the leaf bottom (Veloso and Muraoka, 1993). The leaflets were bent downwards and curled backwards. The stems were thin, fibrous and developed strong, dull purple tints. The leaf area was drastically reduced and the dry matter accumulation also recorded very low.

### Potassium

The earliest recognizable symptom of K deficiency was reduction in growth followed by premature abscission of leaves. In agreement with the report of James *et al* (1995), chlorosis appeared in older leaves with development of necrotic areas at the tip and marginal portions of leaf. Some seedlings exhibited stunted growth but the growth suppression was not severe as in nitrogen and phosphorus deficiencies. The leaf number and seedling height had not shown significant reduction compared to the control, but the leaf area recorded a moderate reduction compared to the control seedlings. The dry matter accumulation in different plant parts also shown significant difference in their values.

### Calcium

Similar to the results reported by Karal (1956) and Gowda *et al* (1991) calcium starved plants in present investigation showed distinctive abnormalities in growth. Plants were highly stunted and bore few number of leaves which were thick, stiff and droopy with up-curved laminae. The stem was stout with dried up terminal part causing the lower auxiliary buds to

Table: Plant growth in tomato seedlings grown with macro nutrient deficiencies

| Treatment | Plant height (cm) | Percentage compared to control | Leaf number | Percentage compared to control | Leaf area $(cm^2)$ | Percentage compared to control | Total dry weight $(gm^{-1})$ | Percentage compared to control |
|---|---|---|---|---|---|---|---|---|
| -N | 7.05 | 28.39 | 6.08 | 38.60 | 9.35 | 8.93 | 0.56 | 16.97 |
| -P | 6.19 | 24.88 | 4.67 | 29.65 | 7.46 | 7.12 | 0.38 | 11.51 |
| -K | 21.82 | 87.70 | 13.17 | 83.62 | 76.50 | 73.04 | 2.60 | 78.76 |
| -Ca | 16.73 | 67.24 | 11.17 | 70.92 | 71.79 | 68.55 | 2.53 | 76.67 |
| -Mg | 21.24 | 85.37 | 13.08 | 83.05 | 73.12 | 69.82 | 2.71 | 82.12 |
| -S | 18.51 | 74.40 | 14.58 | 92.57 | 82.29 | 78.57 | 2.69 | 81.52 |
| Control | 24.88 | 100.00 | 15.75 | 100.00 | 104.73 | 100.00 | 3.30 | 100.00 |
| CD (0.05) | 5.26 | | 3.08 | | 26.92 | | 0.83 | |

develop into small sprouts and the apical growth was arrested. Root system was poorly developed. They were short, stubby and brown in colour with blunt tips. Both leaf number and leaf area shown significant reduction (29.08 and 31.45 per cent respectively) and the dry matter accumulation was also reduced compared to control seedlings (Table).

### Magnesium

Under Mg deficiency, seedlings exhibited the symptoms within 15 days after starting of giving nutrient solution. The plants stunted in growth with few number of leaves and branches. The leaflets of the older leaves developed interveinal chlorosis which advanced inwards from the margins, finally the whole leaf turned yellow. Lamina was brittle and stiff with wavy margins and acute tip. These results are in close conformity with those reported by Roy Chowdhary (1990). A significant reduction in grwoth in terms of number and area of leaf and dry matter accumulation was apparent.

### Sulphur

Seedlings starved with S started exhibiting deficiency symptoms 18 days after giving nutrient solution. Thouh foliar symptoms were not clearly exhibited, leaves were reduced both in size and number and appeared light bluish green in colour. The prominent symptom noticed is S deficient plants was pale yellowing of younger leaves which later turned to yellow colour. The terminal leaves showed a rosette appearance because of congested internodes. These results are in close conformity with those reported by Cerda *et al* (1984) amd Patra *et al* (1998). However, a significant reduction was observed in growth in terms of leaf number and area.

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(Received on 2-1-2001 and revised on 14-6-2001.)

The Andhra Agric. J. 49 (3&4) :280 - 284, 2002

# Effect of Plant Density and Nitrogen on Growth, Flower Yield and Vase Life of Crossandra (*Crossandra infundibuliformis* salisb.)

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## ABSTRACT

Field experiment conducted to study the influence of spacing and nitrogen on growth, flower yield and vase life of crossandra revealed that treatments consisted of three spacings (60 x 15 cm, 60 x 30 cm and 60 x 45 cm) and three levels of nitrogen (15, 100 and 150 kg ha$^{-1}$). Growth characters like number of primary and secondary branches, no. of nodes per plant; leaf area and dry matter production per plant increased significantly with increase in intra - row spacings from 15 to 45 cm and nitrogen levels from 50 to 150 kg ha$^{-1}$. Days to 50 per cent flowering advanced in wider intra-row spacing and at higher levels of nitrogen. Number of flowes and flower yield per plant increased with increase in intra - row spacing and nitrogen levels. Flower yield per hectare was highest under closer spacing and at highest level of nitrogen. The vase life of flowers decreased significantly with increase in intra-row spacing and levels of nitrogen.

**Key Words:** Plant Density, Growth, Yield, Vase Life, Crossandra.

Crossandra is an important commercial flower crop grown for loose flowers in Andhra Pradesh. Too high or too low plant densities per unit area affect the crop yields by influencing moisture and nutrient uptake besides the interception of light. Increase in intra - row spacings was reported to increase the number of flowers per plant where as, flower yield per plot and per hectare was recorded the highest at closer spacings (Chanda and Roy Choudhury, 1991). Nitrogen nutrition is another major factor that influences the productivity of crop in terms of economic yields. Improvement of flowering and flower yield in marigold with the application of nitrogen has been reported by many workers (Singh and Arora, 1980 and Ingawale, 1979). The vase life of crossandra flowers was influenced by different spacings and nitrogen levels (Vijayeswari, 1987; Wadsworth and Butters, 1972). However, such information on crossandra is not available for Chittoor district of A.P. which is one of the leading districts in crossandra cultivation. It was therefore, considered necessary to carryout an investigation to :

(a) standardize agro-techniques like plant density and nitrogen requirement for getting higher yields and (b) studying vase life of flowers.

## MATERIAL AND METHODS

The field experiment was carried out at Horticulture garden of Sri Venkateswara Agricultural College, Tirupati during September

Table 1: Effect of plant density and nitrogen on plant height, primary and secondary branches in crossandra

| Treatments | Plant height (cm) | | | | Primary branches | | | | Secondary branches | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $N_1$ | $N_2$ | $N_3$ | Mean | $N_1$ | $N_2$ | $N_3$ | Mean | $N_1$ | $N_2$ | $N_3$ | Mean |
| $S_1$ | 56.53 | 62.63 | 72.40 | 63.85 | 6.66 | 9.33 | 10.66 | 8.88 | 9.66 | 11.33 | 13.33 | 11.14 |
| $S_2$ | 56.60 | 62.16 | 70.66 | 63.14 | 7.00 | 10.33 | 11.33 | 9.55 | 9.66 | 12.33 | 14.33 | 12.40 |
| $S_3$ | 56.73 | 63.10 | 70.60 | 63.47 | 7.83 | 11.0 | 12.00 | 10.11 | 10.00 | 13.00 | 15.00 | 12.66 |
| Mean | 56.62 | 62.63 | 71.22 | | 7.00 | 10.22 | 11.33 | | 9.77 | 12.22 | 14.22 | |

| | SEm± | CD at 0.05 | SEm± | CD at 0.05 | SEm± | CD at 0.05 |
|---|---|---|---|---|---|---|
| Nitrogen | 0.230 | 0.69 | 0.217 | 0.65 | 0.150 | 0.45 |
| Plant density | 0.230 | NS | 0.217 | 0.65 | 0.150 | 0.45 |
| Nitrogen x Plant density | 0.339 | NS | 0.376 | NS | 0.260 | NS |

NS = Non - significant

Table 2: Effect of plant density and nitrogen on no. of nodes per plant, leaf area per plant and dry matter production per plant in crossandra

| Treatments | No. of nodes per plant | | | | Leaf area (cm²) per plant | | | | Dry matter production (g) per plant | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $N_1$ | $N_2$ | $N_3$ | Mean | $N_1$ | $N_2$ | $N_3$ | Mean | $N_1$ | $N_2$ | $N_3$ | Mean |
| $S_1$ | 6.66 | 11.66 | 12.66 | 10.33 | 1147.4 | 1297.7 | 1337.2 | 1260.7 | 40.99 | 48.88 | 54.79 | 48.22 |
| $S_2$ | 7.99 | 13.33 | 13.33 | 11.44 | 1176.5 | 1327.7 | 1368.0 | 1290.7 | 41.80 | 50.16 | 55.96 | 49.31 |
| $S_3$ | 8.33 | 13.33 | 14.66 | 12.11 | 1203.0 | 1359.6 | 1399.4 | 1320.7 | 41.27 | 49.74 | 58.45 | 49.82 |
| Mean | 7.55 | 12.77 | 13.55 | | 1175.0 | 1328.3 | 1368.2 | | 41.35 | 49.59 | 56.14 | |

| | SEm± | CD at 0.05 | SEm± | CD at 0.05 | SEm± | CD at 0.05 |
|---|---|---|---|---|---|---|
| Nitrogen | 0.122 | 0.36 | 0.639 | 1.91 | 0.623 | 1.80 |
| Plant density | 0.122 | 0.36 | 0.639 | 1.91 | 0.623 | 1.86 |
| Nitrogen x Plant density | 0.211 | NS | 1.10 | 3.31 | 1.080 | NS |

NS = Non - significant

Table 3: Effect of plant density and nitrogen on no. of days to 50 per cent flowering and no. of flowers / plant in crossandra

| Treatments | No. of nodes per plant | | | | Leaf area (cm$^2$) per plant | | | |
|---|---|---|---|---|---|---|---|---|
| | N$_1$ | N$_2$ | N$_3$ | Mean | N$_1$ | N$_2$ | N$_3$ | Mean |
| S$_1$ | 98.33 | 93.33 | 81.66 | 91.11 | 298.0 | 313.3 | 399.6 | 337.0 |
| S$_2$ | 95.00 | 91.33 | 84.33 | 90.22 | 297.6 | 387.0 | 406.0 | 362.5 |
| S$_3$ | 95.33 | 87.33 | 82.00 | 88.22 | 300.6 | 392.0 | 407.3 | 366.6 |
| Mean | 96.22 | 90.66 | 82.66 | | 298.7 | 363.1 | 404.3 | |

| | SEm± | CD at 0.05 | SEm± | CD at 0.05 |
|---|---|---|---|---|
| Nitrogen | 0.639 | 1.91 | 0.91 | 2.74 |
| Plant density | 0.639 | 1.91 | 0.91 | 2.74 |
| Nitrogen x Plant density | 1.10 | 3.31 | 1.58 | 4.75 |

1996 to June 1997 adopting a Factorial Randomized Block Design with nine treatmental combinations and three replications. Treatments consist of three spacings (S1: 60 x 15 cm 11, 1111 plants ha$^{-1}$, S2: 60 x 30 cm - 55,556 plants ha$^{-1}$, and S3; 60 x 45 cm - 37,037 plants ha$^{-1}$) and three levels of nitrogen (N$_1$: 50 kg ha$^{-1}$, N$_2$ : 100 kg ha$^{-1}$ and N$_3$: 150 kg ha$^{-1}$). Observations were recorded on plant height (cm), number of primary and secondary branches, number of nodes, leaf area (cm$^2$), dry matter production (g), number of flowers, flower yield (g) per plot and yield of flowers per hectare (kg). The vase life of loose flowers were tested at room conditions interms of number of hours and was arrived at when 50 per cent flowers were no longer fit for use.

A common dose of FYM @25 tonnes ha$^{-1}$ was applied uniformly to all the plots in the last ploughing and incorporated into the soil before planting the seedlings. Nitrogen in the form of urea was applied as per treatments. Entire recommended dose of phosphorus was applied as basal dressing in the form of single superphosphate and Potassium was applied twice in two equal split doses at the time of planting and 6 months after planting in the form of murate of potash.

The orchard soil was red sandy loam and was found to be low in available nitrogen and phosphorus and rich in potassium with a pH of 6.9. The data on growth parameters were presented at 240 days after transplanting.

## RESULTS AND DISCUSSION

Increase in intra-row spacing upto 45 cm significantly increased all the plant growth parameters (Table 1 & 2) like number of primary and secondary branches, number of nodes, leaf area and dry matter production per plant except plant height. The increase in crop growth may be due to lesser competition between plants, better availability of light, nutrients and water (Ravindran 1980, Chanda and Choudhury 1991).

Plant height, number of primary and secondary branches, number of nodes, leaf area per plant and dry matter production per plant

Table 4: Effect of plant density and nitrogen on flower yield per plot, flower yield per hectare and vase life in crossandra

| Treatments | Flower yield per plot (g) | | | | Flower yield per hectare (kg) | | | | Vase use of flower (hrs) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $N_1$ | $N_2$ | $N_3$ | Mean | $N_1$ | $N_2$ | $N_3$ | Mean | $N_1$ | $N_2$ | $N_3$ | Mean |
| $S_1$ | 217.1 | 233.00 | 301.10 | 250.40 | 542.91 | 582.50 | 752.75 | 626.05 | 84.00 | 72.00 | 60.00 | 72.00 |
| $S_2$ | 179.2 | 246.60 | 245.20 | 223.60 | 448.00 | 616.58 | 556.00 | 585.02 | 60.00 | 60.00 | 48.00 | 56.00 |
| $S_3$ | 139.9 | 222.40 | 229.30 | 197.20 | 349.83 | 556.00 | 573.25 | 493.02 | 48.00 | 48.00 | 48.00 | 48.00 |
| Mean | 178.70 | 234.00 | 258.50 | | 446.91 | 585.02 | 646.33 | | 64.00 | 60.00 | 52.00 | |

| | SEm± | CD at 0.05 | SEm± | CD at 0.05 | SEm± | CD at 0.05 |
|---|---|---|---|---|---|---|
| Nitrogen | 3.24 | 9.73 | 8.11 | 24.34 | 2.66 | 7.99 |
| Plant density | 3.24 | 9.73 | 8.11 | 24.34 | 2.66 | 7.99 |
| Nitrogen x Plant density | 5.62 | 16.80 | 14.06 | 42.16 | 4.61 | NS |

NS = Non - significant

(Tables 1&2) increased significantly with increase in nitrogen application upto 150 kg $ha^{-1}$. The significant increase in growth attributes due to nitrogen application may be due to increased uptake of nitrogen by the plant requiring to intensify the vegetative growth (Ravindran, 1980).

The interaction effect of spacings and nitrogen significantly increased the dry matter production per plant, where as, it is non-significant on the other growth parameters. The reason for this may be due to the combined favourable effects of spacings and nitrogen on plant growth.

The number of days taken for 50 per cent flowering and number of flowers per plant (Table 3) varied significantly with increase in spacing and nitrogen levels. This may be due to availability of more sun light, water and nutrients and also due to increased supply of nitrogen which induced early flowering putting forth a rapid vegetative growth in the initial stages (Khanna *et al.* 1986, Anuradha *et al.*, 1988). The interaction effect of spacings and nitrogen levels significantly reduced the days to 50 per cent flowering and increased the number of flowers per plant. This may be due to combined positive effects of spacings and nitrogen.

The flower yield per plot ($4m^2$) and per hectare (Table 4) was significantly higher at closer spacing and at higher dose of nitrogen. The increase in flower yield both per plot and per hectare at closer spacing (60 x 15 cm) and higher dose of nitrogen (150 kg $ha^{-1}$) may be due to the fact that the plant population per unit area at closer spacing was greater than at wider spacing and increased vegetative growth as a result of higher dose of nitrogen application respectively (Chan *et al.*, 1985 and Pal *et al.*,1984).

Interaction of spacing and nitrogen levels were found to be significant on flower yield per plant as well as flower yield per hectare. Highest flower yield per plot and per hectare was maximum at 60 x 15 cm and 150 kg N $ha^{-1}$.

The yield increase at lower spacing of 60 x 15 cm was 27 per cent over 60 x 45 cm spacing. Similarly the increase in yield at 150 kg N $ha^{-1}$ was 44.6 per cent over 50 kg N $ha^{-1}$ and 30.9 per cent over 100 kg N $ha^{-1}$. The increase in yield at 60 x 15 cm spacing with 150 kg N $ha^{-1}$ was 38.7 per cent over 60 x 15 cm spacing with 50 kg N $ha^{-1}$.

The vase life of flower reduced with increase in intra-row spacing and nitrogen dose (Table 4). The higher levels of nitrogen present in the leaves at wider spacing and also application of higher doses of nitrogen might have reduced the vase life of crossandra flowers (Wadsworth and Butters, 1972 and Vijayaswari, 1987).

Based on the experimental results, it was concluded that a spacing of 60 x 15 cm with nitrogen at the rate of 150 kg $ha^{-1}$ is better for obtaining higher flower yields of crossandra under Tirupati agro-climate conditions though the vase life was decreased.

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(Received on 8-11-2000 and revised on 29-8-2002.)

The Andhra Agric. J. 49 (3&4) :285 - 292, 2002

# Heterosis and Combining Ability in Tomato (*Lycopersicon esculentum* Mill)

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## ABSTRACT

The performance of the six parents Viz., LE-4, LE-16, LE 11, LE-14, LE-8 and LE-19 and the 15 $F_1$ hybrids obtained by diallel crossing without reciprocals were studied by raising the seedlings during *rabi* 2000 - 2001 at Bapatla following all the required cultural practices. Heterosis, general combining ability were estimated. By taking standard heterosis into consideration, LE-14 x LE-18 showed the highest percentage of heterosis for yield (30.33%). The cross LE-14 x LE-8 showed the highest percentage of heterosis for yield (60.64) over better parent. LE-14 showed the highest significant positive *gca* effect for yield. LE-8 showed the highest significant and positive *gca* effects for fruit weight, fruit length, fruit diameter, and thickness of skin. The cross LE-14 x LE-8 showed the highest significant positive *sca* effects for yield and number of branches.

**Key Words :** Heterosis, Combining Ability, Tomato, Reciprocals.-

Tomato (*Lycopersicon esculentum* Mill.) is one of the major vegetable crops grown widely both for fresh market and processing. Tomato though, a self pollinated crop, has a tremendous potential for heteosis breeding. With increasing popularity of $F_1$ hybrids in tomato, it is imperative to obtain such hybrids which have excellent qualities coupled with high yield. A knowledge of *gca* and *sca* helps in choice of parents or hybrids and the nature of gene action acts as a basis of choosing an effective breeding methodology. The present investigation was undertaken to identify such parental combinations that are likely to produce superior hybrids having excellent qualities with high yields.

## MATERIAL AND METHODS

Six diverse genotypes of tomato germplasm viz., LE-4 (V.Sel-13), LE-14 (Selection -4), LE-11 (Megha), LE-8 (HYT-1), LE-16, and LE-19 (Punjab kesari) with different morphological and quantitative attributes were used in the present investigation. The seeds of the six selfed paents were raised in the orchard block of Agricultural College Farm, Bapatla during *kharif* 2000 and were subjected to diallel crossing without reciprocals. The ripe fruits were collected, seeds from each cross were obtained. The $F_1$ seed along with parents were sown in January 2001 and transplanted in February 2001 in Randomized Block Design with three replications. The experimental unit consisted of one row of parent and two rows of Fs, each row being 3.6 m and the seedlings were spaced at 0.6 m within and between the rows. Observations are recorded on five plants in each replication on plant height, number of branches, days to 50% flowering, fruit weight, fruit length, fruit diameter, thickness of skin, TSS, number of fruits per plant, and yield per plant.

The analysis of variance for each character was carried out by the method suggested by Panse and Sukhatme (1967).

Heterosis was worked out over mid, better and standard parents. The method 11, model 1 suggested by Griffings (1956) was adopted to estimate the combining ability.

## RESULTS AND DISCUSSION

The mean performance of parents and hybrids was presented in Table 1. The parent LE-4 showed higher mean performance for plant height, number of branches and number of fruits per plant. LE-14 showed higher mean performance for yield. Among the cross combinations LE-14 X LE-8 showed higher mean performance for yield.

The heterosis values over mid parent, better parent and standard variety were presented in Table 2. Le-8 x LE-19 and LE-11 x LE-8 exhibited the highest percentage of heterosis into consideration, the cross LE-14 x LE-8 was found to be superior. The cross LE-14 x LE-8 recorded the highest positive significant *sca* effects. LE-14 x LE-11 and LE-8 x LE-19 also recorded significant *sca* effects, Similarly, Srivastava *et al.* (1998) reported that the $F_1$ crosses which showed high *sca* effects also exhibited higher heterosis for yield. The high *per se* performance of the above crosses was mainly through the involvement of the best general combiners vig., LE-14 and LE-8. This type of positive relation between *per se* performance and *sca* effects would, be more useful while undertaking a breeding programme.

Few crosses showed negative heterosis for yield. Similar results were reported by Mageswari and Natarajan (1997) and Aruna and Veeraragavathatham (1997). The $F_1$ hybid LE-4 x LE-19 recorded the highest value of heterosis over better and standard parents for number of fruits per plant. LE-14 x LE-8 also recorded the highest values of heterosis over mid and standard parents for number of branches. LE-16 x LE-8 recorded the highest values of heterosis over mid and better parents for total soluble solids and over mid parent it showed the heighest value of heterosis for plant height. Regarding days to 50 per cent flowering, most of the crosses exhibited negative heterosis over their mid, better and standard parental value, indicating a general tendency of earlines in hybrids.

The heterotic effects of hybrids for different yield attributes were reported by Aruna and Veeraragavathatham (1997) for number of fruits per plant, individual fruit weight and yield per plant; Mageswari and Natarajan (1997) for TSS, ascorbic acid, yield per plant, number of fruits per plant and mean fruit weight; and Uppal *et al.* (1997) for total yield, number of fruits per plant and total soluble solids.

The variances due to *gca* and *sca* were significant for all the characters studied suggesting the importance of additive and non additive gene action (Table 3). Further the magnitude of variance due to *gca* was less than that of *sca* for all the characters studied except fruit weight and fruit length. The high magnitude of *sca* variances over *gca* variances indicate the predominant role of non additive gene action. Similar results were reported by Patil and Bojappa (1986) and Srivastava *et al.* (1998).

The general combining ability values (Table 4) are the highest in LE-14 for yield. LE-4 recorded highest values for number of fruits, plant height and number of branches. LE-8 recorded the highest values for, fruit weight, fruit length, fruit diameter and thickness of skin. Similar results of high *gca* effects were reported by Patil and Bojappa (1986) in Pusa Ruby for number of flowers per inflorescence, number of fruit per plant, seed and locule number per fruit.

In case of specific combining ability effects different crosses were found to be superior for different traits. However, the cross of LE-14 x

Table 1 : Mean performance of 10 characters of tomato from 6 x 6 diallel crosses

| Treatments | Plant height (cm) | Number of branches | Days to 50% flowering | Fruit weight (g) | Fruit length (cm) | Fruit diameter (cm) | Thickness of skin | T.S.S ($^{0}$Brix) | Number of fruits per plant | Yield gram / plant |
|---|---|---|---|---|---|---|---|---|---|---|
| LE-4 | 136.66 | 14.2 | 33.00 | 23.30 | 2.83 | 2.83 | 3.14 | 4.70 | 48.33 | 1145.00 |
| LE-16 | 80.60 | 10.66 | 32.66 | 51.22 | 3.03 | 2.54 | 3.69 | 3.88 | 24.66 | 1263.33 |
| LE-14 | 83.33 | 10.33 | 32.66 | 52.80 | 3.16 | 3.83 | 3.46 | 4.15 | 28.33 | 1500.00 |
| LE-11 | 68.4 | 7.80 | 34.33 | 44.50 | 3.90 | 3.78 | 4.13 | 4.02 | 29.66 | 1337.00 |
| LE-8 | 63.6 | 7.20 | 31.00 | 55.00 | 5.44 | 4.00 | 6.34 | 3.91 | 18.00 | 990.00 |
| LE-19 | 76.93 | 8.66 | 32.66 | 22.16 | 3.44 | 2.44 | 3.68 | 4.96 | 46.00 | 1226.66 |
| LE-4 X LE-16 | 131.66 | 10.66 | 33.33 | 32.35 | 3.41 | 3.24 | 3.34 | 5.22 | 41.33 | 1440.00 |
| LE-4 X LE-14 | 125.4 | 11.53 | 29.00 | 34.80 | 3.31 | 3.25 | 3.46 | 4.84 | 44.33 | 1550.00 |
| LE-4 X LE-11 | 110.2 | 9.66 | 30.66 | 52.15 | 3.66 | 3.44 | 3.90 | 4.72 | 27.33 | 1480.00 |
| LE-4 X LE-8 | 114.2 | 9.53 | 32.66 | 42.00 | 3.44 | 3.47 | 3.62 | 4.77 | 22.33 | 1080.00 |
| LE-4 X LE-19 | 122.8 | 9.46 | 32.00 | 22.10 | 2.99 | 2.55 | 3.47 | 5.06 | 55.00 | 1200.00 |
| LE-16 X LE-14 | 91.33 | 8.93 | 31.66 | 60.00 | 3.38 | 2.98 | 3.34 | 4.73 | 25.66 | 1666.66 |
| LE-16 X LE-11 | 120.26 | 9.93 | 33.00 | 52.50 | 3.76 | 3.34 | 3.81 | 4.30 | 28.00 | 1523.23 |
| LE-16 X LE-8 | 105.46 | 9.23 | 30.33 | 54.50 | 3.44 | 3.13 | 3.86 | 4.93 | 28.33 | 1640.00 |
| LE-16 X LE-19 | 90.00 | 9.00 | 31.00 | 50.22 | 3.31 | 2.86 | 3.23 | 5.04 | 29.33 | 1520.00 |
| LE-14 X LE-11 | 85.2 | 9.93 | 29.33 | 53.03 | 3.44 | 2.97 | 3.38 | 5.13 | 28.66 | 1646.66 |
| LE-14 X LE-8 | 93.93 | 14.00 | 29.00 | 65.33 | 3.85 | 3.35 | 2.97 | 4.8 | 30.66 | 2000.00 |
| LE-14 X LE-19 | 99.8 | 9.53 | 32.00 | 44.50 | 3.68 | 3.19 | 4.35 | 4.90 | 33.66 | 1500.00 |
| LE-11 X LE-8 | 88.33 | 10.80 | 29.66 | 50.50 | 3.99 | 2.92 | 3.23 | 4.95 | 28.00 | 1520.00 |
| LE-11 X LE-19 | 85.2 | 11.53 | 30.00 | 54.15 | 3.72 | 3.25 | 4.13 | 5.06 | 26.66 | 1550.00 |
| LE- 8 X LE-19 | 64.13 | 8.60 | 31.00 | 52.00 | 4.61 | 3.07 | 3.70 | 5.19 | 23.66 | 1490.00 |
| Grand mean | 97.02 | 10.05 | 31.49 | 46.14 | 3.61 | 3.16 | 3.73 | 4.72 | 31.80 | 1443.26 |
| SEM ± | 4.21 | 0.85 | 0.94 | 2.22 | 0.19 | 0.17 | 0.27 | 0.18 | 2.09 | 121.83 |
| C.D at (0.05) | 11.66 | 2.36 | 2.60 | 6.17 | 0.54 | 0.48 | 0.75 | 0.50 | 5.79 | 337.70 |
| C.D at (0.01) | 15.29 | 3.09 | 3.41 | 8.09 | 0.72 | 0.63 | 0.99 | 0.66 | 7.59 | 442.82 |
| CV % | 7.50 | 14.67 | 5.18 | 8.36 | 9.56 | 9.61 | 12.69 | 6.67 | 11.38 | 14.62 |

Table 2 : Estimats of relative heterosis, heterobeltiosis and standard heterosis for 10 characters from 6 x 6 diallel crosses of tomato

| Treatments | Plant height<br>Heterosis over | | | | Number of branches<br>Heterosis over | | | | Days to 50%flowering<br>Heterosis over | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | MP | BP | SV | Mean | MP | BP | SV | Mean | MP | BP | SV |
| LE-4 X LE-16 | 131.66 | 21.20** | -3.65 | 58.00** | 10.66 | -14.20 | -24.88** | 3.22 | 33.66 | 4.56 | -2.97 | 5.10 |
| LE-4 X LE-14 | 125.40 | 14.00* | -8.24 | 50.48** | 11.53 | -5.97 | -18.77* | 11.61 | 29.0 | -9.64* | 11.20* | -9.18* |
| LE-4 X LE-11 | 110.20 | 7.47 | -19.36** | 32.24** | 9.66 | -12.12 | -31.92** | -6.45 | 30.66 | -8.91* | 0.07 | -6.12 |
| LE-4 X LE-8 | 114.20 | 14.04* | -16.43** | 37.04** | 9.53 | -10.90 | -32.86** | -7.74 | 32.66 | 2.08 | -5.08 | 0.00 |
| LE-4 X LE-19 | 122.80 | 14.98* | -10.14* | 47.36** | 9.46 | -17.20 | -33.33** | -8.38 | 32.0 | -2.53 | 2.06 | -2.04 |
| LE-16 X LE-14 | 91.33 | 11.42 | 9.60 | 9.60 | 8.93 | -14.92 | -16.25 | -13.54 | 31.66 | -3.06 | 3.06 | -3.06 |
| LE-16 X LE-11 | 120.26 | 61.43** | 49.21** | 44.32** | 9.93 | 7.58 | -6.87 | -3.87 | 33.00 | -1.49 | -1.03 | 1.02 |
| LE-16 X LE-8 | 105.46 | 46.27** | 30.85** | 26.56** | 9.23 | 3.35 | -13.43 | -10.64 | 30.33 | -4.71 | 2.20 | -7.14 |
| LE-16 X LE-19 | 90.00 | 14.26 | 11.66 | 8.00 | 9.00 | -6.89 | -15.62 | -12.90 | 31.00 | -5.10 | 5.35* | -5.10 |
| LE-14 X LE-11 | 85.20 | 12.30 | 2.24 | 2.24 | 9.93 | 9.55 | -3.87 | -3.87 | 29.33 | -12.43** | 12.62* | -10.20* |
| LE-14 X LE-8 | 93.93 | 27.85** | 12.72 | 12.72 | 14.0 | 59.69** | 35.48** | 35.48** | 29.00 | -8.90* | 6.89* | -11.22** |
| LE-14 X LE-19 | 99.80 | 24.54** | 19.76** | 19.76** | 9.53 | 0.35 | -7.74 | -7.74 | 32.00 | -2.04 | 2.06 | -2.04 |
| LE-11 X LE-8 | 88.33 | 33.83** | 29.14** | 6.00 | 10.8 | 44.00** | 38.46* | 4.51 | 29.66 | -9.18* | 6.89 | -9.18* |
| LE-11 X LE-19 | 85.20 | 17.24* | 10.74 | 2.24 | 11.53 | 40.08** | 33.07* | 11.61 | 30.00 | -10.44 | 8.86* | -8.16 |
| LE- 8 X LE-19 | 64.13 | -8.72 | -16.63* | -23.04** | 8.6 | 8.40 | -0.76 | -16.77 | 31.00 | -2.61 | 0.00 | -5.10 |

Table 2 continued

| Treatments | Plant height Heterosis over | | | | Number of branches Heterosis over | | | | Days to 50%flowering Heterosis over | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | MP | BP | SV | Mean | MP | BP | SV | Mean | MP | BP | SV |
| LE-4 X LE-16 | 32.35 | -13.41* | -36.84* | -38.73* | 3.41 | 16.38 | 12.54 | 7.79 | 3.24 | 20.67** | 14.48 | -15.40* |
| LE-4 X LE-14 | 34.8 | -8.54 | -34.09* | -34.09* | 3.31 | 10.67 | 4.84 | 4.84 | 3.25 | -2.20 | -14.96* | -14.96* |
| LE-4 X LE-11 | 52.15 | 53.83* | 17.19* | 1.23* | 3.66 | 8.75 | -6.22 | 15.80 | 3.44 | 3.97 | -9.15 | -10.18 |
| LE-4 X LE-8 | 42.0 | 7.279 | -23.63* | -20.45* | 3.44 | -16.84* | -36.80** | 8.74 | 3.47 | 1.60 | -13.31* | -9.31 |
| LE-4 X LE-19 | 22.1 | -2.77 | -5.15* | -58.14* | 2.99 | -4.41 | -12.88 | -5.26 | 2.55 | -3.22 | -9.89 | -33.42** |
| LE-16 X LE-14 | 60.0 | 15.36* | 13.63* | 13.63* | 3.38 | 9.25 | 6.95 | 6.95 | 2.98 | -6.22 | -22.01** | -22.09** |
| LE-16 X LE-11 | 52.5 | 9.69 | 2.49* | -0.568* | 3.76 | 8.50 | -3.66 | 18.96* | 3.34 | 5.69 | -11.70 | -12.70 |
| LE-16 X LE-8 | 54.5 | 2.61 | -0.90* | 3.2196* | 3.44 | -18.80** | -36.80** | 8.74 | 3.13 | -4.37 | -21.88** | -18.27** |
| LE-16 X LE-19 | 50.22 | 36.87* | -1.95* | -4.88* | 3.31 | 2.31 | -3.77 | 4.63 | 2.86 | 14.99 | 12.72 | -25.23** |
| LE-14 X LE-11 | 53.03 | 9.00 | 0.43* | 0.43* | 3.44 | -2.68 | -11.94 | 8.74 | 2.97 | -21.92** | -22.36** | -22.36** |
| LE-14 X LE-8 | 65.3 | 21.2 | 18.78* | 23.73* | 3.85 | -10.53 | -29.27** | 21.70* | 3.35 | -14.41* | -16.30* | -12.44 |
| LE-14 X LE-19 | 44.5 | 18.72* | -15.71* | -15.71* | 3.68 | 11.66 | 7.17 | 16.54 | 3.19 | 1.96 | -16.53* | -16.53* |
| LE-11 X LE-8 | 50.5 | 1.50 | -8.18* | -4.35* | 3.99 | -4.50* | -26.57** | 26.34** | 2.92 | -25.06** | -27.12** | -23.75** |
| LE-11 X LE-19 | 54.15 | 62.4* | 21.68* | 2.55* | 3.72 | 1.27 | -4.77 | 17.59 | 3.25 | 4.49 | -14.08* | -15.05* |
| LE- 8 X LE-19 | 52.0 | 25.8* | -5.45* | -1.51* | 4.61 | 3.78 | -15.30** | 45.73** | 3.07 | -4.65 | -23.29** | -19.75** |

Table 2 continued

| Treatments | Plant height | | | | Number of branches | | | | Days to 50%flowering | | | | Yield | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Heterosis over | | | | Heterosis over | | | | Heterosis over | | | | Heterosis over | | |
| | Mean | MP | BP | SV | Mean | MP | BP | SV | Mean | MP | BP | SV | Mean | MP | BP | SV |
| LE-4 X LE-16 | 3.34 | -2.100 | -9.41 | -3.28 | 5.22 | 21.58** | 11.06 | 25.78** | 41.33 | 13.24 | -14.48* | 45.88** | 1440.00 | 19.58 | 13.98 | -4.00 |
| LE-4 X LE-14 | 3.46 | 4.85 | 0.03 | 0.03 | 4.84 | 9.45 | 3.04 | 16.70* | 44.33 | 15.65* | -8.27 | 56.47** | 1550.00 | 17.20 | 3.33 | 3.33 |
| LE-4 X LE-11 | 3.90 | 7.33 | -5.49 | 12.79 | 4.72 | 8.25 | 0.42 | 13.73* | 27.33 | -29.91** | -43.44** | -3.52 | 1480.00 | 19.5 | 10.69 | -1.33 |
| LE-4 X LE-8 | 3.62 | -23.67** | -42.94** | 4.63 | 4.77 | 10.95 | 1.63 | 15.10* | 22.33 | -32.66* | -53.79** | -21.17* | 1080.00 | 1.17 | -5.67 | -28.00* |
| LE-4 X LE-19 | 3.47 | 1.74 | -5.70 | 0.32 | 5.06 | 4.89 | 2.15 | 22.08** | 55.00 | 16.60* | 13.79* | 94.11** | 1200.00 | -0.48 | -5.26 | -20.00 |
| LE-16 X LE-14 | 3.34 | -6.68 | -9.64 | -3.52 | 4.73 | 17.71** | 13.97* | 13.97* | 25.66 | -3.13 | -9.41 | -9.41 | 1666.66 | 20.62 | 11.11 | 11.11 |
| LE-16 X LE-11 | 3.87 | -1.12 | -6.34 | 11.78 | 4.30 | 8.93 | 7.13 | 3.77 | 28.00 | 3.06 | -5.61 | -1.17 | 1523.33 | 17.16 | 13.93 | 1.555 |
| LE-16 X LE-8 | 3.86 | -23.04** | -39.11 | 11.64 | 4.93 | 26.63** | 26.25** | 18.95** | 28.33 | 32.81* | 14.86 | 0.00 | 1640.00 | 45.56** | 29.81* | 9.33 |
| LE-16 X LE-19 | 3.23 | -12.28 | -12.43 | -6.50 | 5.04 | 14.01* | 1.68 | 21.52** | 29.33 | -16.98* | -36.23** | 3.52 | 1520.00 | 20.15 | 20.00 | 1.33 |
| LE-14 X LE-11 | 3.38 | -10.98 | -18.19 | -2.36 | 5.13 | 25.66** | 23.69** | 23.69** | 28.66 | -1.14 | -3.3708 | 1.17 | 1646.66 | 16.08 | 9.77 | 9.77 |
| LE-14 X LE-8 | 2.97 | -39.41** | -53.18** | -14.16 | 4.80 | 19.10** | 15.66* | 15.66* | 30.66 | 32.37* | 8.23 | 8.23 | 2000.00 | 60.64** | 33.33 | 33.33 |
| LE-14 X LE-19 | 4.35 | 21.85 | 18.19 | 25.74** | 4.90 | 7.64 | -1.14 | 18.15** | 33.66 | -9.41 | -26.81** | 18.82 | 15.20.00 | 8.43 | 0.00 | 0.00 |
| LE-11 X LE-8 | 3.23 | -38.27** | -49.05** | -6.57 | 4.95 | 24.92** | 23.21** | 19.35** | 28.00 | 17.48 | -5.61 | -1.17 | 1520.00 | 30.64* | 13.68 | 1.33 |
| LE-11 X LE-19 | 4.13 | 5.77 | 0.03 | 19.39 | 5.06 | 12.69* | 2.01 | 21.92** | 26.66 | -29.51** | -42.02** | -5.88 | 1550.00 | 19.06 | 15.93 | 3.33 |
| LE- 8 X LE-19 | 3.703 | -26.16** | -41.66** | 6.97 | 5.19 | 17.17** | 4.77 | 25.22** | 23.66 | -26.04** | -48.55** | -16.47 | 1490.00 | 32.05* | 17.63 | 0.66 |

Table 3 : Analysis of variance for combining ability for 10 characters in 6 X 6 diallel crosses of tomato.

| | | Mean sum of squares | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Source of variation | d.f | Plant height (cm) | Number of branches | Days to 50% flowering | Fruit weight | Fruit length | Fruit diameter | Thickness of skin | T.S.S | Number of fruits per plant | Yield |
| General combining ability | 5 | 1357.76** | 3.63* | 2.41* | 307.38* | 0.96* | 0.36* | 0.60* | 0.19* | 237.05* | 77477.27* |
| specific combining ability | 15 | 191.04* | 2.77* | 2.47 | 101.05* | 0.11 | 0.10* | 0.44* | 0.17* | 42.33* | 44260.73* |
| Error | 40 | 17.74 | 0.726 | 0.89 | 4.96 | 0.03 | 0.03 | 0.07 | 0.03 | 4.36 | 14844.73 |
| SEM ± | | 2.43 | 0.491 | 0:54 | 1.28 | 0.11 | 0:10 | 0.15 | 0.10 | 1.20 | 70.34 |
| C.D (0.05%) | | 6.73 | 1.36 | 1.51 | 3.56 | 0.31 | 0.28 | 0.43 | 0.29 | 3.34 | 194.75 |

Table 4: General combining ability effects for 10 characters of 6 parents used in 6 x 6 diallel set of tomato.

| Parents | Plant height (cm) | Number of branches | Days to 50% flowering | Fruit weight | Fruit length | Fruit diameter | Thickness of skin | T.S.S | Number of fruits per plant | Yield |
|---|---|---|---|---|---|---|---|---|---|---|
| LE-4 | 24.80** | 1.10** | 0.55 | -7.75** | -0.34** | -0.06 | -0.25** | 0.11* | 8.04** | -132.86** |
| LE-16 | 2.59 | -0.16 | 0.59* | 2.41** | -0.23 | -0.18** | -0.13 | -0.13* | -2.58** | 26.73 |
| LE-14 | -2.10 | 0.52 | -0.48 | 3.35** | -0.15 | 0.15** | -0.21* | -0.04 | -0.37 | 157.55** |
| LE-11 | -6.64** | -0.36 | 0.05 | 2.35** | 0.13* | 0.16** | 0.08 | -0.11 | -3.08** | 36.38 |
| LE-8 | -10.73** | -0.48 | -0.77* | 4.27** | 0.61** | 0.22** | 0.49** | -0.07 | -6.70** | -49.11 |
| LE-19 | -7.91** | -0.61* | 0.05 | -4.64** | -0.09 | -0.29** | 0.01 | 0.26** | 4.70** | -38.69 |
| S.E (g) ± | 1.35 | 0.27 | 0.30 | 0.71 | 0.06 | 0.05 | 0.08 | 0.05 | 0.67 | 39.32 |
| Se = $(g_i-g_j)$ ± | 2.10 | 0.42 | 0.22 | 1.11 | 0.08 | 0.08 | 0.13 | 0.09 | 1.04 | 60.91 |

LE-8 showed the highest *sca* effect for yield and number of branches, LE-4 x LE-19 for number of fruits per plant, LE-11 x LE-8 for fruit weight and LE-14 x LE-11 for TSS content.

Considering the degree of heterosis and the effects of *gca* and *sca*, the cross combination LE-14 x LE-8 can be exploited. Taking into account, the significance of *gca* and *sca* variances, biparental mating followed by recurrent selection would be an appropriate technique for exploiting the additive and non additive genetic components. The potentiality of a strain to be used as a parent in the hybridization programme may be judged by comparing the *per se* performance and the combining ability.

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(Received on 26-9-2001 and revised on 29-8-2002.)

The Andhra Agric. J. 49 (3&4) :293 - 298, 2002

# Effect of Post Harvest Ripening and Storage Treatments on Chemical Constituents of Sapota (*Achras Zapota* L.)

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## ABSTRACT

An investigation was undertaken to study the effect of ripening initiating chemical like ethrel, $CaC_2$ and NaOH on the ripening behaviour of sapota (*Achras Zapota* L.) and the effect of fungicidal wax emulsion and certain chemicals like $GA_3$, Alar and $KMnO_4$ on chemical constituents during the storage of fruits harvested at full maturity and three - fourth maturity stages. Full mature fruits recorded the higher total and reducing sugars at eating ripe stage than three - fourth mature fruits. Higher TSS and acidity were found in three - fourth mature fruits. Higher percentages of reducing and non-reducing sugars and higher acidity were observed in fungicidal wax emulsion treated fruits. Among the ripening initiation treatments, NaOH recorded the higher reducing and non-reducing sugars, acidity and lower values with $CaC_2$ treatment. TSS was found to be more in ethrel treated fruits. Of the interaction effects, full mature fruits treated with ethrel + fungicidal wax emulsion recorded the highest reducing and non-reducing sugars. Three - fourth mature fruits treated with ethrel + $GA_3$ recorded higher TSS. Higher acidity was found in three - fourth mature fruits treated with NaOH + fungicidal wax emulsion.

**Key Words :** Post harvest, Ripening, Storage, Chemical Constituents, Shelf - Life.

The artificial ripening of sapota is still a crude method followed by the fruit merchants which results in improper ripening of fruits making them tasteless. Besides, the sapota fruits had a shorter shelf - life resulting in huge storage losses and market glut. Sapota fruits if harvested at proper stage of maturity and properly ripened will have good quality and fetch a good price. Quality of any fruit largely depends upon certain chemical constituents like sugars and acids. Different ripening and storage treatments are found to show greater influence on the fruit quality. Therefore, the present investigation was carried out to study the effect of post harvest ripening and storage treatments on the chemical constituents in sapota fruits harvested at three - fourth and full maturity stages.

## MATERIAL AND METHODS

Sapota fruits of Cv. Pala at three - fourth and full maturity stages as judged by colour and intensity of scurf on the fruit were selected and harvested. The fruits were of same size and maturity under each set. The ripening initiation treatments included were ethrel at 750 ppm, Calcium carbide @ 10 g /100 fruits and NaOH @ 5 g/100 fruits. The $CaC_2$ (10g) was wrapped in a cloth and placed in the middle of bamboo basket. The baskets were kept in a polythene bag with 3 or 4 holes and placed in the bamboo basket containing sapota fruits.

The storage treatments were $GA_3$ 100 ppm ($S_1$), 6 per cent fungicidal wax emulsion using 2 per cent Bavistin as the fungicide ($S_2$),

Table 1: Changes in respiration (mg $CO_2$ / kg/ hr) of sapota fruits harvested at full and three - fourth maturity stages as influenced by different ripening initiation treatments at 12 hours interval.

| Treatments | Full maturity | | | | Three - fourth maturity | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 12 | 24 | 36 | 0 | 12 | 24 | 36 | 48 |
| Ethrel | 22.00 | 12.17 | 2.03 | 18.608 | 100.72 | 47.65 | 32.13 | 5.13 | 14.56 |
| $CaC_2$ | 22.00 | 1.739 | 18.32 | - | 100.72 | 66.87 | 7.54 | 30.72 | - |
| NaOH | 22.00 | 18.45 | 5.82 | 14.190 | 100.72 | 58.076 | 38.04 | 10.19 | 12.18 |

Alar 200 ppm ($S_3$) and $KMnO_4$ 500 ppm ($S_4$) and no treatment ($S_0$). These treatments were imposed after the ripening was initiated. The ripening initiation was ascertained based on the respiration studies. The fruits were dipped in treatment solution for 2 minutes, removed and dried at room temperature. All the treated fruits were packed in bamboo baskets lined with paddy straw. The experiment was carried out in a Randomized Block Design with factorial concept and replicated twice. The fruits treated with ripening initiation chemicals without any storage treatments were considered as their respective controls. Data on changes in chemical constituents of sapota fruits viz., total sugars, reducing sugars, non reducing sugars, TSS and titrable acidity was recorded every day after imposing the storage treatments.

## RESULTS AND DISCUSSION

### Ripening Initiation

Early ripening initiation of both full mature and three - fourth mature fruits was observed with calcium carbide treatment compared to ethrel and NaOH treatments (Table 1). The data revealed that initially the respiration rate was more and gradually decreased with a sharp rise at the ripe stage. Biale and Young (1981) also observed the same trend and reported that a close examination of the respiratory course of a climacteric fruit showed a declining trend to the lowest value termed as per-climacteric minimum followed by a more or less sharp rise to the climacteric peak and subsequent "Post - Climacteric decline" in the rate of respiration.

### After The Storage Treatments

Data on total sugar content (Table 2) revealed that at eating ripe stage, full mature fruits recorded significantly higher sugar percentage (10.71%) than three - fourth mature fruits (10.50%). Of the ripening initiating chemcals NaOH treated fruits registered higher total sugar content (10.66%) followed by ethrel (10.61%). The fruits treated with fungicidal wax emulsion recorded the highest total sugar content (10.81%) and the lowest with Alar treatment (10.48%). Among the combination treatments full mature fruits treated with ethrel + fungicidal wax emulsion, NaOH + fungicidal wax emulsion recorded higher total sugar contents (11.12, 11.01 and 10.91% respectively). Three - fourth mature fruits treated with $CaC_2$ alone recorded the lowest values which might be due to partial hydrolysis of starch.

Data pertaining to percentage or reducing sugars (Table 3) revealed that the fruits of full maturity and three - fourth maturity recorded 8.34 and 8.23 per cent of reducing sugars respectively. Significantly higher reducing sugar

Table 2 : Sucrose (%) of Sapota Fruits Harvested at full and Three - Fourth maturity stages as influenced by different ripening and storage treatments at eating ripe stage.

| | $m_1$ | | | | $m_2$ | | | | | Mean | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $l_1$ | $l_2$ | $l_3$ | Mean (ms) | $l_1$ | $l_2$ | $l_3$ | Mean (ms) | Mean (s) | | $(l_s)$ | |
| $S_0$ | 10.71<br>(19.10) | 10.52<br>(18.93) | 10.64<br>(19.03) | 10.62<br>(19.01) | 10.64<br>(19.03) | 10.13<br>(18.56) | 10.59<br>(18.99) | 10.45<br>(18.86) | 10.53<br>(18.94) | 10.67<br>(19.06) | 10.32<br>(18.74) | 10.61<br>(19.00) |
| $S_1$ | 10.71<br>(19.10) | 10.80<br>(19.19) | 10.79<br>(19.18) | 10.76<br>(19.15) | 10.45<br>(18.86) | 10.74<br>(19.13) | 10.47<br>(18.88) | 10.55<br>(18.95) | 10.65<br>(19.04) | 10.58<br>(18.98) | 10.77<br>(19.16) | 10.63<br>(19.02) |
| $S_2$ | 11.12<br>(19.60) | 10.73<br>(19.12) | 11.01<br>(19.38) | 10.95<br>(19.32) | 10.52<br>(18.93) | 10.63<br>(19.02) | 10.91<br>(19.23) | 10.68<br>(19.07) | 10.81<br>(19.20) | 10.82<br>(19.30) | 10.68<br>(19.07) | 10.96<br>(19.33) |
| $S_3$ | 10.69<br>(19.08) | 10.52<br>(18.93) | 10.73<br>(19.12) | 10.60<br>(19.00) | 10.22<br>(18.65) | 10.43<br>(18.84) | 10.47<br>(18.88) | 10.37<br>(18.78) | 10.48<br>(18.89) | 10.45<br>(18.86) | 10.47<br>(18.88) | 10.60<br>(19.00) |
| $S_4$ | 10.65<br>(19.04) | 10.66<br>(19.05) | 10.53<br>(18.93) | 10.61<br>(19.00) | 10.47<br>(18.88) | 10.52<br>(18.93) | 10.49<br>(18.89) | 10.49<br>(18.89) | 10.55<br>(18.95) | 10.56<br>(18.96) | 10.59<br>(18.99) | 10.51<br>(18.91) |
| Mean (ml) | 10.77<br>(19.16) | 10.64<br>(19.03) | 10.74<br>(19.13) | 10.71<br>(19.09) | 10.46<br>(18..87) | 10.49<br>(118.89 | 10.58<br>(18.98) | 10.50<br>(18.91) | | | | |
| Mean (s) | | | | | 10.61<br>(19.00) | 10.56<br>(18.96) | 10.66<br>(19.05) | | | | | |
| | m | l | s | ml | ms | ls | mls | | | | | |
| SEd ± | 0.0400 | 0.0480 | 0.0630 | 0.0690 | 0.0890 | 0.1090 | 0.1540 | | | | | |
| CD at 0.05 | 0.0810 | NS | 0.1290 | NS | NS | NS | NS | | | | | |
| CV % | 0.81 | | | | | | | | | | | |

m = Stages of harvest

l = Ripening initiation treatments

s = Storage treatments

$m_1$ = Full maturity

$m_2$ = Three - fourth maturity

$l_1$ = Ethrel 750 ppm

$l_2$ = Calcium carbide 10g/100 fruits

$l_3$ = Sodium hydroxide 5g/100 fruits

$S_0$ = Control

$S_1$ = $GA_3$ 100 ppm

$S_2$ = Fungicidal wax emulsion (6%)

$S_3$ = Alar 200 ppm

$S_4$ = $KMnO_4$ 500 ppm

* Figures in parentheses indicate angular transformed values.

Table 3 : Reducing sugars (%) of sapota fruits harvested at full and Three - Fourth maturity stages as influenced by different ripening and storage treatments at eating ripe stage.

|  | $m_1$ |  |  |  | $m_2$ |  |  |  |  | Mean |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | $l_1$ | $l_2$ | $l_3$ | Mean (ms) | $l_1$ | $l_2$ | $l_3$ | Mean (ms) | Mean (s) | (ls) |  |  |
| $S_0$ | 8.260 | 8.170 | 8.400 | 8.270 | 8.160 | 8.000 | 8.160 | 8.100 | 8.180 | 8.210 | 8.080 | 8.280 |
|  | (16.70) | (16.61) | (16.80) | (16.71) | (16.60) | (16.43) | (16.60) | (16.54) | (16.62) | (16.65) | (16.52) | (16.72) |
| $S_1$ | 8.230 | 8.490 | 8.300 | 8.340 | 8.210 | 8.350 | 8.350 | 8.300 | 8.320 | 8.220 | 8.420 | 8.320 |
|  | (16.65) | (16.94) | (16.72) | (16.80) | (16.64) | (16.77) | (16.77) | (16.74) | (16.77) | (16.66) | (16.92) | (16.77) |
| $S_2$ | 8.800 | 8.310 | 8.600 | 8.570 | 8.215 | 8.130 | 8.390 | 8.250 | 8.400 | 8.500 | 8.220 | 8.490 |
|  | (17.26) | (16.75) | (17.10) | (17.07) | (16.66) | (16.35) | (16.79) | (16.79) | (16.90) | (17.00) | (16.66) | (16.99) |
| $S_3$ | 8.260 | 8.190 | 8.170 | 8.200 | 8.165 | 8.100 | 8.335 | 8.200 | 8.200 | 8.210 | 8.140 | 8.250 |
|  | (16.69) | (16.63) | (16.61) | (16.64) | (16.61) | (16.53) | (16.76) | (16.64) | (16.64) | (16.65) | (16.58) | (16.69) |
| $S_4$ | 8.355 | 8.335 | 8.300 | 8.330 | 8.260 | 8.365 | 8.210 | 8.270 | 8.300 | 8.300 | 8.350 | 8.250 |
|  | (16.78) | (16.78) | (16.74) | (16.79) | (16.70) | (16.79) | (16.65) | (16.71) | (16.74) | (16.74) | (16.82) | (16.69) |
| Mean (ml) | 8.380 | 8.300 | 8.350 | 8.340 | 8.206 | 8.190 | 8.290 | 8.230 |  |  |  |  |
|  | (16.87) | (16.74) | (16.82) | (16.80) | (16.64) | (16.63) | (16.73) | (16.67) |  |  |  |  |
| Mean (l) |  |  |  |  | 8.290 | 8.240 | 8.320 |  |  |  |  |  |
|  |  |  |  |  | (16.73) | (16.68) | (16.78) |  |  |  |  |  |
|  | m | l | s | ml | ms | ls | mls |  |  |  |  |  |
| SEd ± | 0.0170 | 0.0200 | 0.0260 | 0.0290 | 0.0370 | 0.0460 | 0.0650 |  |  |  |  |  |
| CD at 0.05 | 0.0340 | 0.0420 | 0.054 | NS | 0.0770 | 0.0940 | 0.1340 |  |  |  |  |  |
| CV% | 0.3920 |  |  |  |  |  |  |  |  |  |  |  |

Table 4 : Total soluble solids (°Brix) of sapota fruits harvested at full and three - fourth maturity stages as influenced by different ripening and storage treatments at eating ripe stage.

| | $m_1$ | | | | $m_2$ | | | | | Mean | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $l_1$ | $l_2$ | $l_3$ | Mean (ms) | $l_1$ | $l_2$ | $l_3$ | Mean (ms) | Mean (s) | | ($l_s$) | |
| $S_0$ | 24.62 | 25.13 | 24.63 | 24.79 | 25.55 | 26.14 | 24.63 | 25.44 | 25.12 | 25.09 | 25.64 | 24.63 |
| $S_1$ | 26.00 | 24.13 | 25.09 | 25.07 | 28.50 | 25.05 | 24.09 | 25.88 | 25.48 | 27.25 | 24.59 | 24.59 |
| $S_2$ | 23.95 | 24.19 | 24.00 | 24.05 | 24.72 | 25.07 | 24.50 | 24.76 | 24.40 | 24.34 | 24.63 | 24.25 |
| $S_3$ | 26.05 | 26.00 | 25.07 | 25.71 | 28.00 | 27.56 | 26.00 | 26.56 | 26.08 | 27.00 | 26.78 | 25.53 |
| $S_4$ | 24.56 | 24.50 | 24.30 | 24.45 | 24.05 | 25.62 | 24.50 | 24.72 | 24.59 | 24.31 | 25.06 | 24.40 |
| Mean (ml) | 25.04 | 24.79 | 24.62 | 24.81 | 26.39 | 25.89 | 24.74 | 25.67 | | | | |
| Mean (l) | | | | | 25.71 | 25.34 | 24.68 | | | | | |
| | m | l | s | ml | ms | ls | mls | | | | | |
| SEd ± | 0.1690 | 0.2070 | 0.268 | 0.293 | 0.379 | 0.464 | 0.657 | | | | | |
| CD at 0.05 | 0.3470 | 0.4250 | 0.548 | 0.601 | NS | 0.950 | NS | | | | | |
| CV% | 2.60 | | | | | | | | | | | |

Table 5: Titrable acidity (meq/100g pulp) of Sapota Fruits harvested at full and Three - fourth Maturity Stages as influenced by different ripening and storage treatments at eating ripe stage.

| | $m_1$ | | | | $m_2$ | | | | | Mean | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $l_1$ | $l_2$ | $l_3$ | Mean (ms) | $l_1$ | $l_2$ | $l_3$ | Mean (ms) | Mean (s) | | (ls) | |
| $S_0$ | 4.705 | 4.220 | 4.760 | 4.560 | 4.815 | 4.500 | 4.880 | 4.731 | 4.645 | 4.760 | 4.360 | 4.820 |
| $S_1$ | 4.760 | 4.670 | 4.820 | 4.750 | 4.890 | 4.765 | 4.995 | 4.883 | 4.816 | 4.825 | 4.717 | 4.907 |
| $S_2$ | 5.110 | 4.815 | 5.090 | 5.005 | 5.210 | 4.895 | 5.320 | 5.141 | 5.073 | 5.160 | 4.855 | 5.205 |
| $S_3$ | 4.600 | 4.350 | 4.740 | 4.563 | 4.710 | 4.650 | 5.000 | 4.786 | 4.674 | 4.655 | 4.500 | 4.870 |
| $S_4$ | 4.815 | 4.760 | 4.840 | 4.805 | 4.905 | 4.810 | 5.060 | 4.918 | 4.861 | 4.860 | 4.785 | 4.940 |
| Mean (ml) | 4.798 | 4.563 | 4.850 | 4.736 | 4.906 | 4.724 | 5.047 | 4.890 | | | | |
| Mean (l) | | | | | 4.852 | 4.643 | 4.948 | | | | | |
| | m | l | s | ml | ms | ls | mls | | | | | |
| SEd ± | 0.0200 | 0.0300 | 0.038 | 0.042 | 0.054 | 0.067 | 0.094 | | | | | |
| CD at 0.05 | 0.0500 | 0.0600 | 0.079 | NS | NS | 0.137 | NS | | | | | |
| CV% | 3.37 | | | | | | | | | | | |

content was recorded by NaOH treatment (8.32%) among the ripening initiation treatment (8.32%). Of the storage treatments, fruits treated with fungicidal wax emulsion recorded the highest reducing sugar content of 8.4 per cent while the lowest value with control (8.18%). Full mature fruits treated with ethrel + fungicidal wax emulsion showed higher content of reducing sugars (8.8%) and lowest with $CaC_2$ and $CaC_2$+ Alar treatments (8.0 and 8.1% respectively).

Fruits of three - fourth maturity recored the highest TSS content (25.67° Brix) than those of full mature fruits (24.81° Brix) (Table 4). Fruits treated with ethrel recorded the highest TSS content (25.70° Brix) among ripening initiation treatments. In respect of interaction, the higher TSS was recorded in three - fourth mature fruits treated with ethrel + $GA_3$ (28.50° Brix) followed by ethrel + Alar (28.00° Brix) and were on par. The lowest TSS content was observed in full mature fruits treated with ethrel + fungicidal wax emulsion (23.05° Brix) followed by NaOH + fungicidal wax emulsion (24.0° Brix) and ethrel + $KMnO_4$ (24.0° Brix) treatments of three - fourth mature fruits. Wax coating of fruits resulted in slower increase in TSS which clearly indicated the delay in ripening.

Three-fourth mature fruits recorded significantly higher acidity (4.89 meq/100g pulp) than full mature fruits (4.73 meq/100 g pulp) (Table 5). Fruits treated with fungicidal wax emulsion recorded significantly higher acidity (5.073 meq/100 g pulp). The lowest acidity was recorded with control fruits. Among interactions three - fourth mature fruits treated with NaOH + fungicidal wax emulsion recorded the highest acidity (5.32 meq/100 g pulp). The lowest acidity was recorded with $CaC_2$ and $CaC_2$ + Alar treatments of full mature fruits (4.22 and 4.35 meq/100 g pulp). The lower values of acidity in control fruits may be due to increased respiratory activity leading to increased utilization of organic acids (Garg *et al.*, 1971).

Ripening initiating and storage treatments showed significant influence on the fruit quality in terms of Brix, total and reducing sugars and acidity in sapota. In general, fruits harvested at full maturity stage had higher total and reducing sugars at eating ripe stage, while fruits harvested at three - fourth mature stage had higher TSS and acidity. Treatment with ethrel and fungicidal wax emulsion found to increase the total and reducing sugars in fruits harvested at full maturity and treatment with ethrel + $GA_3$ significantly enhanced. The content in three-fourth mature sapota fruits.

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(Received on 31-12 - 2001 and revised on 4 -1- 2002 .)

The Andhra Agric. J. 49 (3&4) : 299 - 303, 2002

# Biochemical Constituents of Chillies CV. LCA 235 as Influenced by Chemical Emulsions and Drying Methods

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## ABSTRACT

Laboratory study conducted to estimate the bio-chemical constituents of Cv LCA-235 like capsaicin, capsanthin and oleoresin as influenced by chemical emulsion treatments and drying methods in order to assess the quality of chilli fruit. Maximum percentage of oleoresin was recorded by chilli produce dried under open yard sundrying. Among chemical emulsions, potassium sulphate emulsion treatment recorded 11.66 per cent maximum oleoresin content. Maximum EOA colour value for capsanthin was recorded by solar drying method. Calcium carbonate emulsion recorded the maximum EOA colour value of 23,776.44 and 18,367.00 in first and second pickings respectively. However, maximum percentage of capsaicin was recorded by traydrier and was found superior over other methods of drying. Among chemical emulsions, potassium sulphate recorded the maximum percentage of capsaicin. Among interactions, PSE-OYSD for oleoresins, CCE-SD for EOA colour value and PSE-TD for capsaicin recorded the maximum values. Based on the above quality parameters it is necssary to choose the drying method for the kind of marketing viz., domestic market, export purpose and industrial purpose.

**Key Words :** Biochemical constituents, Chemical Emulsions, Dry Methods, oleoresin, Pungency, Carotenoids.

Of the essential qualities of chillies, the most important are pungency, colour and oleoresin. Pungency is the descriminating property of chillies and depending upon the method of drying and handling procedure, the pungency is varying. Similarly colour is ranked as a prized quality characteristic of chillies and commercially important. The pigments comprising the colour is a complex mixture of carotenoids. Though 31 carotenoids have been detected so far, the most improtant is capsanthin which comprises 32.2 per cent of carotenoid blend (Verghese *et al.*, 1992). This colour richness in chillies depends on diverse factors, but drying procedures and pre-treatments being the most effective ones. Oleoresin representing the complete flavour profile consists of the volatile essential oil and non-volatile resinous fraction Hence, oleoresin is designated as true essence of spice and can replace whole or ground spice with out impairing any flavour characteristics. With these points in view, an attempt was made to determine the bio-chemical constituents viz., capsaicin, capsanthin and oleoresin contents as influenced by various methods of drying and pre-treatment with chemical emulsions.

## MATERIAL AND METHODS

A laboratory experiment was conducted twice with chilli produce of January and March 2001 pickings in the Horticulture laboratory, Agricultural College, Bapatla to study the bio-chemical constituents of chillies viz., capsaicin, capsanthin and oleoresin contents in Randomised Block Design with factorial concept. The chilli produce of Cv. LCA 235 was obtained from the farm of a progressive farmer of

Table 1 : The effect of Methods of Drying, Chemical emulsions and their interactions on percentage capsaicin in first picking and second picking produce.

| Chemical emulsions | Methods of drying | | | Mean |
|---|---|---|---|---|
| | OYSD | TD | SD | |
| | | First Picking | | |
| NCE | 0.440 | 0.552 | 0.602 | 0.531 |
| CCE | 0.472 | 1.00 | 0.647 | 0.706 |
| PSE | 0.701 | 0.894 | 0.809 | 0.801 |
| PNE | 0.693 | 0.629 | 0.768 | 0.697 |
| Mean | 0.576 | 0.769 | 0.706 | |
| | SEm ± | CD(0.05) | CV% | |
| Methods of drying (D) | 0.0007 | 0.002 | 0.347 | |
| Chemical emulsions (C) | 0.0008 | 0.0023 | | |
| D x C | 0.0013 | 0.0038 | | |
| | | Second Picking | | |
| NCE | 0.44 | 0.513 | 0.621 | 0.527 |
| CCE | 0.523 | 0.633 | 0.812 | 0.661 |
| PSE | 0.735 | 0.826 | 0.677 | 0.741 |
| PNE | 0.605 | 0.712 | 0.522 | 0.613 |
| Mean | 0.557 | 0.668 | 0.661 | |
| | SEm ± | CD(0.05) | CV% | |
| Methods of drying (D) | 0.0005 | 0.00146 | 0.26 | |
| Chemical emulsions (C) | 0.0006 | 0.00175 | | |
| D x C | 0.0010 | 0.00293 | | |

Ponnekallu village in Guntur district. The experimentation includes twelve treatments (three chemical emulsions and one control as one factor and three drying methods as second factor). Both experiments of first and second pickings were replicated thrice with 750 g of ripened chilli produce in each and was subjected to the above treatments and analysed for bio-chemical constituents. The capsaicin content was determined by colorimetric method as outlined by Roserbrook *et al.* (1968.) The data were statistically analysed in both pickings as outlined by Bajaj and Kaur (1979). Oleoresin and colour values were determined as outlined by Roserbrook *et al.* (1968). The data were statistically analysed in both pickings as per statistical procedures of Panse and Sukhatme (1978).

## RESULTS AND DISCUSSION

The data presented in Table 1 of first and second pickings respectively showed that per cent of capsaicin was significantly influenced by methods of drying, pre-treatment with chemical emulsions and their interactions. Maximum percentage of capsaicin was recorded by TD (0.769% and 0.668% in first and second pickings respectively) and was found to be significantly superior over other drying methods. The produce dried under open yard sundrying method

Table 2 : The effect of Methods of Drying, Chemical emulsions and their interactions on Capsanthin content in first picking and second picking produce.

| Chemical emulsions | Methods of drying<br>OYSD | <br>TD | <br>SD | Mean |
|---|---|---|---|---|
| | | First Picking | | |
| NCE | 16673.33 | 22102..33 | 24217.00 | 20997.55 |
| CCE | 21899.00 | 24644.00 | 24786.33 | 23776.44 |
| PSE | 18828.66 | 23220.66 | 24603.33 | 22217 |
| PNE | 19113.33 | 23769.66 | 24644.33 | 22515.77 |
| Mean | 19128.58 | 23434.16 | 24567.75 | |
| | SEm ± | CD(0.05) | CV% | |
| Methods of drying (D) | 26.76 | 78.47 | 0.41 | |
| Chemical emulsions (C) | 30.90 | 90.64 | | |
| D x C | 53.53 | 156.99 | | |
| | | Second Picking | | |
| NCE | 13908.00 | 16366.66 | 17446.00 | 15873.55 |
| CCE | 15290.66 | 15961.66 | 23830.66 | 18367.00 |
| PSE | 14701.00 | 17954.33 | 16754.66 | 16470.00 |
| PNE | 14741.66 | 15290.66 | 19093.00 | 16375.11 |
| Mean | 15250.00 | 15978.66 | 19281.08 | |
| | SEm ± | CD(0.05) | CV% | |
| Methods of drying (D) | 299.56 | 878.5 | 6.19 | |
| Chemical emulsions (C) | 345.9 | 1014.39 | | |
| D x C | 599.12 | 1757.00 | | |

recorded the capsaicin content 0.576 per cent and 0.557 per cent in first and second pickings respectively. Thus this has clearly demonstrated the effectiveness of tray drier to retain the capsaicin content to its maximum without any loss. It could be attributed to uniform temperature of 45$^0$C maintained for a short perod of 2 to 2.5 days. The results are in agreement with those reported by Mangaraj et al., (2001). The lower values under OYSD in both pickings could be due to fluctuations in the temperature and the adverse effects of oxidation by exposing to the sunlight for longer period of 10 days. Similar results attributing the above reasons were reported by Philip and Francis (1971).

With regard to pre-treatment of produce with chemical emulsions the maximum capsaicin content was recorded by PSE (0.801% and 0.741% in first and second pickings respectively) which was found to be significantly superior over the other treatments. it was followed by the treatment CCE (0.706% and 0.661% in first and second pickings respectively). It is interesting to note that contrary to earlier reports suggesting calcium carbonate, in the present study potassium sulphate emulsion has recorded the superior influence by maintaining the higher percentage of capsaicin content in both the pickings. Among ineractions the treatment combination of the above mentioned PSE

Table 3 : The effect of Methods of Drying, Chemical emulsions and their interactions on percentage of Oleoresin in first and second picking produce.

| Chemical emulsions | Methods of drying | | | Mean |
|---|---|---|---|---|
| | OYSD | TD | SD | |
| | | First Picking | | |
| NCE | 11.633 | 10.60 | 11.40 | 11.21 |
| CCE | 12.30 | 10.20 | 11.23 | 11.24 |
| PSE | 14.53 | 8.46 | 10.66 | 11.22 |
| PNE | 12.20 | 9.90 | 10.16 | 10.75 |
| Mean | 12.66 | 9.79 | 10.86 | |
| | SEm ± | CD(0.05) | CV% | |
| Methods of drying (D) | 0.211 | 0.619 | 6.59 | |
| Chemical emulsions (C) | 0.244 | NS | | |
| D x C | 0.422 | 1.239 | | |
| | | Second Picking | | |
| NCE | 11.76 | 9.63 | 11.56 | 10.98 |
| CCE | 12.70 | 9.867 | 11.53 | 11.36 |
| PSE | 13.33 | 10.56 | 11.10 | 11.66 |
| PNE | 11.80 | 10.23 | 11.90 | 11.31 |
| Mean | 12.40 | 10.07 | 11.52 | |
| | SEm ± | CD(0.05) | CV% | |
| Methods of drying (D) | 0.046 | 0.137 | 1.43 | |
| Chemical emulsions (C) | 0.054 | 0.158 | | |
| D x C | 0.093 | 0.275 | | |

treatment with TD method of drying recorded the maximum percentage of capsaicin (0.894% and 0.826% in first and second pickings respectively). This combination is clearly confirming the earlier superior effects of TD method and PSE chemical emulsion treatments.

With regard to capsanthin content, the data presented in Table 2 of both the pickings indicated significant differences among the methods of drying, pre-treatment with chemical emulsions and their interactions. The pods treated with CCE and dried in SD have shown a highly significant influence on capsanthin content (EOA colour value) independently as well as their combination. It was followed by treatment combination PNE-SD independently and together gave better results. However, it is interesting to note the reduction in the EOA values of the colour in the second picking produce when compared to the first picking produce. These results were nearer to those reported by Krishnamurthy and Natarajan (1973). The reason could be attributed to the presence of capsanthin and capsorubin in the greatest amount in the first harvest of chillies but a decrease in subsequent harvests. In both the pickings TD method was found to be better one compared to OYSD. It is also interesting to note from the present study that in both pickings, the EOA colour values of capsanthin were found to be the lowest in OYSD indicating the adverse effect of high intensity sunlight coupled with fluctuations in the temperatures.

Even the pre-treatment of produce with chemical emulsions prior to OYSD could not control the loss of colour, indicating that choosing of drying method is more important for better retention of colour. Further, among the pre-treatment with chemical emulsions CCE had shown good results of higher values of EOA. It could be due to the strong adsorption affinity of capsanthin with adsorbants like calcium carbonate as explained by Krishnamurthy and Natarajan (1973).

The data pertaining to oleoresin presented in Table 3 showed a significant effect due to drying methods, chemical emulsions and their interactions. Among methods of drying, OYSD method recorded the maximum per cent of oleoresin (12.66% and 12.40% in first and second pickings respectively) which was significantly superior over the other drying methods while the minimum percentage of oleoresin was recorded by TD (9.79%, 9.633% in first and second pickings respectively). The less per cent of oleoresin in TD method could be attributed to the sensitivity of oleoresins to continuous heating and similar results reported by Rajagopal (1996). Pertaining to the treatment of chemical emulsions, the data showed non-significant differences in first picking produce and significant differences in second picking produce. However, it is interesting to note that in general, the pre-treatment with chemical emulsions showed relatively higher percentage of oleoresin content. Among the interaction effect of drying methods and pre-treatment with chemical emulsions, the treatment combination PSE-OYSD followed by CCE-OYSD showed remarkably maximum oleoresin content in both the pickings.

Based on the above findings, it was found the drying of chilli produce Cv. LCA-235 in tray drier with prior pre-treatment of PSE for capsaicin, OYSD with prior treatment of PSE for oleoresin, and SD with prior treatment of CCE for capsanthin were beneficial and accordingly the produce of high quality may be developed for marketing either for domestic or export purpose.

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(Received on 20-6-2002 and revised on 4-10-2002.)

The Andhra Agric. J. 49 (3&4) : 304 - 306, 2002

# Management of Anthracnose Disease Using Plant Extracts in Cashew

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## ABSTRACT

The plant extract of *Azadirachta indica* followed by *Parthenium hysterophorus* were highly effective in reducing the growth and spore germination of *Colletoctrichum gloeosporioides in vitro.* Extract of *Vinca rosea* was found to be the least effective and the plant extract of *Azadirachta Indica* was found to be effective in the management of Anthracnose disease of cashew seedlings, followed by extracts of *Parthenium hysterophorus, Polyalthia longifolia, Lantana camara. Vinca rosea was found to be least effective.*

**Key Words :** Anthracnose, Plant Extract, Cashew, Perthenium

The presence of naturally occurring substances in plants with, antifungal properties have been recognized and tested against a wide range of fungi infecting many crops and commercially important plants (Pan *et al.*, 1985; Singh and Dwivedi, 1990). The studies on the control of fungal pathogens of cashew by means other than the chemical fungicides are meager. The present investigation was therefore, under taken to test the efficacy of plant extracts of *Azadirachta indica* A. Juss, *Catharanthus roseus* (L). *Parthenium hysterophorus* (L), *Polyalthia lagifolia* L. and *Lantana camara* (L) against the *Colltotrichum gloeosporioides* causing anthracnose of cashew in nurseries and gardens.

## MATERIAL AND METHODS

To study the effect of plant extracts on growth and spore germination of *C. gloeosporioides* plant extracts of *Azadirachta indica, Parthenium hysterophorus, Lantana camara, Vinca rosea* and *Polyalthia longifolia* were prepared separately as follows.

### Plant extract preparation

Fresh plant material of different plant species was thoroughly cleaned, surface sterilized with ethanol and washed with sterile water. The plant tissue was ground along with sterilized water at the rate of 1ml per g of plant tissue using a pestle and mortar, and the macerate was expressed using muslin cloth to filter the extract. The extract was diluted by adding sterile water to make 10 per cent concentration.

### Effect of plant extracts on growth

The plant extracts were incorporated into agar media by transferring 2 ml of each type of plant extract into a Petridish containing melted warm agar medium and gently shaking the Petridish for even mixing of the extract. The agar plates containing the plant extracts were inoculated aseptically with *Colletotrichum gloeosporioides* by transferring a small mycelial disc of 5 mm size with help of a sterilized cork borer from 10-day old culture to the centre of agar medium in the Petridish. The inoculated media were incubated at room temperature (28 ± 1°C) for 10 days. Four replications were maintained for each plant extract. The growth of the fungus in respect of different plant extracts was estimated by measuring the diameter of the colony and per cent inhibition of growth was estimated by using the following formula. Agar plate without any plant extract served as control.

$$\text{Per cent inhibition} = \frac{\text{Radial growth in control} - \text{Radial growth in treatment}}{\text{Radial growth in control}} \times 100$$

### Effect of plant extracts on spore germination

< The plant extracts were tested for their efficacy in inhibiting spore germination of *Colletotrichum gloeosporioides* by incubating a drop of each plant extract along with a drop of a spore suspension of *C. gloeosporioides* in a cavity slide kept in a moist chamber. For each plant extract 4 replications were maintained. Each cavity slide constituted one replication and in each replication 10 microscopic fields were observed, each microscopic field containing 10-15 spores. The slides were incubated for 60, 120, 180 min and after each incubation period the germinated spores were counted and expressed as percentage of spore germination. A spore was considered to have germinated if the germ tube was about more than half of length of the spore.

### Effect of plant extracts on anthracnose disease

In the cashew nursery, to study the efficacy of the plant extracts in the management of anthracnose disease of cashew, 15-day old cashew seedlings showing symptoms of anthracnose were sprayed with the extracts of different plant species viz., *Azadirachta indica, Parthenium hysteroporus, Lantana camara, Vinca rosea* and *Polyalthia longifolia* separately. After 15 days, the second spray was given. Four replications were maintained for each plant extract and each replication consisted of 4 seedlings. Seedlings not sprayed with plant extracts served as control. The disease incidence and PDI were estimated 10 days after second spray. The Per cent Disease Control (PDC) was estimated by the following formula.

$$\text{Per cent Disease Control (PDC)} = \frac{\text{PDI in control} - \text{PDI in treatment}}{\text{PDI in control}} \times 100$$

## RESULTS AND DISCUSSION

In the present study significant reduction in growth and spore germination of *C. gloeosporioides* was observed in respect of all the plant extracts tested. The results indicated (Table) that the plant extracts of *Azadirachta indica* followed by *Parthenium hysterophorus* were effective in reducing the growth and spore germination of *C. gloeosporioides* and extracts of *Vinca rosea* was least effective. These plant extracts seemed to be consistent in their effect on the spore germination after 60, 120 and 180 min of incubation period.

The earlier literature revealed that the plant extracts of several *croton* spp, were observed to be inhibitory to growth of *C. gloeosporioides* (Bandara *et al.* 1986), while the spore germination was inhibited by the extracts of *Saraca asoca, Abrus precatorius, Carum copticum* and cabbage and raddish (Annapurna *et al*, 1999; Dixit *et al.*, 1986).

The fungitoxicity of the plant extracts in the present study may be due to antifungal metabolites present in different plant species, Singh *et al.* (1987) reported that a compound called Ajoene isolated from garlic inhibited spore germination of *Colletotrichum* sp, *Curvularia* sp. and *Alternaria* sp.

From the results presented in the Table 3 it is obvious that all the plant extracts significantly

Table : Effect of plant extracts on the growth of *Colletotrichum gloeosporioides invitro* and Management of *Anthracnose* disease of cashew seedling

| Plant extracts | Concentration (per cent) | *Diameter of the colony (mm) | Per cent inhibition over control | Per cent disease severity (PDI)* | Per cent disease control (PDC) |
|---|---|---|---|---|---|
| *Azadirachta indica* (Neem) | 10 | 10.37 | 87.52 | 22.75<br>(28.46) | 53.94 |
| *Parthenium hysterophorus* | 10 | 16.32 | 80.36 | 25.46<br>(30.28) | 48.46 |
| *Lantana camara* | 10 | 25.25 | 69.62 | 28.76<br>(32.41) | 41.78 |
| *Polyalthia longifolia* | 10 | 37.72 | 54.61 | 26.53<br>(30.95) | 46.29 |
| *Vinca rosea* | 10 | 42.60 | 48.74 | 34.59<br>(35.92) | 29.97 |
| Control | | 83.00 | 0.00 | 49.40<br>(44.64) | 0.00 |
| SEm± | | 4.97 | | 0.45 | |
| CD (0.05) | | 14.76 | | 1.33 | |

* Mean of four replications Figures in parantheses are arc sine transform values.

reduced the disease over control. The extracts of *Azadirachta indica* were found to be the best recording 22.75 PDI followed by *Parthenium hysterophorus* (25.46PDI) and *Polyalthia longifolia* (26.53 PDI). *Lantana camara* and *Vinca rosea* also significantly reduced the PDI to 28.76 and 34.59 respectively from 49.40 PDI recorded in control. Several workers reported the efficacy of plant extracts in the management of various plant diseases.

The fungi-toxicity *Azadirachta indica* against *Alternaria porri* causing of onion purple blotch (Datar, 1993) *Fusarium moniliformi* (Gopi and Wala, 1995) and *Curvularia lunata* (Annapurna *et al.*, 1986) was earlier reported. Similarly the effect of extracts of *Polylthia longifolia* against *Colletotrichum gloeosporioides* (Annapurna *et al.* 1986) *Alternaria alterneta* (Annapurna, *et al.*, 1986) and *Alternaria porri* (Datar, 1993) were discussed. Sarvamangala *et al.* (1993) observed that aqueous extracts of *parthenium hysterophorus* were effective against mulberry rust and leaf spot diseases. The fungi - toxicity of *Vinca rosea* against *Fusarium solani* and *Lantana camara* against *Curvuleria lunata* (Vardhani, 1981) was observed.

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(Received on 18-4-2000 and revised on 12-5-2001.)

The Andhra Agric. J. 49 (3&4) :307-312, 2002

# Studies on Genetic Variability Parameters In a Set of Parental Lines and Their $F_2$ Population In Rice (*Oryza sativa* L.)

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## ABSTRACT

Ten parents and their nine $F_2$ populations were evaluated for genetic variability, heritability and genetic advance for yield component characters. This study revealed highly significant differences among the parents and $F_2$'s for all the characters except for panicle length in parents and for harvest index and days to 50 per cent flowering in $F_2$'s. A wide range of variation was observed for mean values for panicle length, productive tillers per plant height, grains per panicle, plant dry matter and grain yield in parents and for grains per panicle and plant dry matter in $F_2$ population indicating the presence of ample variation for these characters in the present material. High heritability coupled with high genetic advance observed for plant height and number of grains per panicle in parents and for plant height along in $F_2$'s indicated the presence of additive gene action and these characters could be improved by simple selection procedures.

**Key Words :** Variablity, Heritability, Genetic advance, Segregating, populations

In order to obtain genetic improvement of rice crop; higher productivity is a prime need. The knowledge on the nature and magnitude of genetic variation in respect of quantitative characters like yield and its components is essential for effecting crop yield improvement. The estimate of mean serves as a basis for eliminating undersirable crosses where as, genetic variability (*GCV* and *PCV*) helps to choose a potential cross. Heritability ($h^2$) along with genetic advance as per cent of meat (GA) would be more useful tool in predicting the resultant effect from selection of best genotypes for various important yield attributes and yield. With this back ground in view, ten parents and their nine $F_2$ populations were studied for 12 economic traits in rice.

## MATERIAL AND METHODS

The nine $F_2$ cross combinations (NLR 9674 / CR 1009, NLR 33648 / NLR 33891, NLR 33641 / MTU 5249, CR 1009 / BCP 1, NLR 33648 / MTU 7029, CR 1009 / NLR 33891, CR 1009 / MTU 7014, CR 1009 / MTU 5249 and CR 1009 / BPT 5204) were raised in a Randomised Block Design replicated thrice, along with the parents, during *kharif*, 2000 at Agricultural Research Station, Nellore. Observations on various yield component and quality characters including grain yield were recorded on 20 randomly selected plants in each treatment in each of replication for all the parental lines as well as $F_2$ populations. GCV and PCV (Burton, 1952), heritability in broad sense (Singh and Chaudhary, 1979) and expected genetic advance (Allard, 1960) were calculated following the standard procedures.

Table 1: Analysis of variance for yield and yield component characters in parents and $F_2$ populations of nine rice crosses.

| | | Mean Squares | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Source | Df | Plant height (cm) | Panicle length (cm) | Productive tillers/ plant | Grains / panicle | Plant dry matter(g) | Harvest Index | Days to 50 per cent flowering | Days to Maturity | Kernel length (mm) | Kernel breadth (mm) | L/B ratio | Grain yield (g) |
| **Parents** | | | | | | | | | | | | | |
| Replications | 2 | 127.7344 | 2.0791 | 0.0802 | 748.0000 | 1.7227 | 11.6328 | 13.6406 | 2.0625 | 0.0244 | 0.0033 | 0.0029 | 3.8823 |
| Treatments | 9 | 1281.1702** | 6.7448 | 5.6068** | 8707.0557** | 141.1846** | 65.2587** | 54.5243** | 148.2569* | 1.1617** | 0.0572** | 0.3082** | 141.3643** |
| Error | 18 | 9.7743 | 2.9227 | 0.5911 | 687.5625 | 1.0922 | 10.1150 | 11.0764 | 43.8090 | 0.0197 | 0.0041 | 0.0057 | 3.7666 |
| **$F_2$ populations** | | | | | | | | | | | | | |
| Replication | 2 | 1.8906 | 10.7832 | 2.5228 | 55.5625 | 3.0898 | 38.1113 | 230.4844 | 1.8125 | 0.0036 | 0.0371 | 0.0278 | 10.5493 |
| Treatments | 8 | 191.3711** | 10.9238** | 2.6532* | 3087.9297* | 38.1873** | 24.2500 | 295.9844 | 49.5391* | 0.1776* | 0.0410* | 0.0969* | 13.6302* |
| Error | 16 | 13.7969 | 1.6934 | 0.5476 | 799.2266 | 1.7662 | 13.3611 | 185.6055 | 13.8984 | 0.0352 | 0.0078 | 0.0216 | 4.4301 |

* Significant at 0.05 per cent level. ** significant at 0.01 per cent level.

Table 2 : Mean values of $F_2$ populations of nine rice crosses

| Parents | Plant height (cm) | Panicle length (cm) | Productive tillers/ plant | Grains / panicle | Plant dry matter(g) | Harvest Index | Days to 50 per cent flowering | Days to Maturity | Kernel length (mm) | Kernel breadth (mm) | L/B ratio | Grain yield (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NLR 9674 x CR 1009 | 109.57 | 25.80 | 7.77 | 161.47 | 20.10 | 45.33 | 107.00 | 134.67 | 5.19 | 2.58 | 2.01 | 17.10 |
| NLR 33648 x NLR 33891 | 117.37 | 27.40 | 7.17 | 195.07 | 24.07 | 43.00 | 107.67 | 137.67 | 5.98 | 2.31 | 2.52 | 19.13 |
| NLR 33641 x MTU 5249 | 97.87 | 21.33 | 7.23 | 179.27 | 14.33 | 47.67 | 111.33 | 145.33 | 5.67 | 2.37 | 2.50 | 13.33 |
| CR 1009 x BCP 1 | 104.03 | 23.40 | 8.53 | 148.77 | 23.80 | 46.67 | 110.67 | 140.67 | 5.34 | 2.55 | 2.04 | 17.66 |
| NLR 33648 x MTU 7029 | 96.47 | 21.90 | 6.13 | 152.27 | 13.70 | 49.33 | 109.33 | 144.00 | 5.76 | 2.43 | 2.34 | 13.83 |
| CR 1009 x NLR 33891 | 109.47 | 25.23 | 8.17 | 152.57 | 20.00 | 46.33 | 111.67 | 141.67 | 5.64 | 2.44 | 2.31 | 17.76 |
| CR 1009 x MTU 7014 | 93.93 | 24.50 | 9.40 | 173.70 | 19.20 | 49.33 | 117.67 | 146.33 | 5.47 | 2.62 | 2.09 | 18.90 |
| CR 1009 x MTU 5249 | 103.03 | 24.90 | 8.20 | 153.83 | 18.30 | 49.67 | 139.33 | 146.00 | 5.64 | 2.47 | 2.25 | 18.92 |
| CR 1009 x BPT 5204 | 94.83 | 23.47 | 7.37 | 229.03 | 20.13 | 45.33 | 115.00 | 145.00 | 5.37 | 2.29 | 2.35 | 17.43 |
| Range | 93.93 | 21.33 | 6.13 | 148.77 | 13.70 | 43.00 | 107.00 | 134.67 | 5.19 | 2.29 | 2.01 | 13.33 |
| | 117.37 | 27.40 | 9.40 | 229.03 | 24.07 | 49.67 | 139.33 | 146.33 | 5.98 | 2.62 | 2.52 | 19.13 |
| Mean | 102.95 | 24.21 | 7.77 | 171.77 | 19.30 | 46.96 | 114.41 | 142.37 | 5.56 | 2.45 | 2.27 | 17.12 |
| SED | 3.03 | 1.06 | 0.60 | 2308 | 1.08 | 3.11 | 11.12 | 3.04 | 0.15 | 0.07 | 0.11 | 1.71 |
| CV % | 3.6 | 5.4 | 9.52 | 17.24 | 6.89 | 8.11 | 11.91 | 2.62 | 3.37 | 3.61 | 6.46 | 12.29 |

Table 3 : Mean values of parents of nine rice crosses

| Parents | Plant height (cm) | Panicle length (cm) | Productive tillers/ plant | Grains / panicle | Plant dry matter(g) | Harvest Index | Days to 50 per cent flowering | Days to Maturity | Kernel length (mm) | Kernel breadth (mm) | L/B ratio | Grain yield (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NLR 9674 | 103.96 | 24.56 | 8.43 | 222.36 | 24.56 | 47.66 | 123.00 | 156.66 | 5.15 | 2.46 | 2.09 | 22.73 |
| CR 1009 | 101.26 | 23.50 | 8.80 | 160.70 | 23.06 | 52.33 | 120.33 | 145.33 | 5.12 | 2.65 | 1.94 | 24.23 |
| NLR 33648 | 121.76 | 25.03 | 7.63 | 287.53 | 21.86 | 52.66 | 123.33 | 151.00 | 5.31 | 2.38 | 2.23 | 24.80 |
| NLR 33641 | 114.20 | 24.90 | 9.06 | 204.83 | 20.90 | 54.66 | 122.66 | 154.33 | 5.66 | 2.43 | 2.32 | 25.50 |
| MTU 5249 | 83.76 | 22.43 | 7.76 | 215.16 | 21.06 | 51.66 | 118.66 | 147.00 | 5.50 | 2.33 | 2.34 | 22.73 |
| BCP 1 | 139.46 | 23.43 | 7.66 | 127.73 | 35.80 | 41.33 | 120.33 | 150.66 | 5.46 | 2.45 | 2.23 | 25.03 |
| MTU 7029 | 80.06 | 21.16 | 4.73 | 134.30 | 13.20 | 42.66 | 118.66 | 143.33 | 5.38 | 2.24 | 2.42 | 9.93 |
| NLR 33891 | 106.73 | 24.50 | 6.63 | 208.36 | 25.46 | 54.33 | 115.00 | 144.66 | 5.24 | 2.45 | 2.22 | 30.93 |
| MTU 7014 | 69.43 | 21.06 | 5.96 | 117.33 | 10.43 | 41.33 | 109.66 | 131.33 | 7.20 | 2.40 | 2.99 | 9.23 |
| BPT 5204 | 102.53 | 24.63 | 8.46 | 197.56 | 22.43 | 49.00 | 116.00 | 146.00 | 6.03 | 2.14 | 2.82 | 20.50 |
| Range | 69.43 | 21.06 | 4.73 | 117.33 | 10.43 | 41.33 | 109.66 | 131.33 | 5.12 | 2.14 | 1.94 | 9.23 |
|  | 139.46 | 25.03 | 9.06 | 287.53 | 35.80 | 54.66 | 123.33 | 156.67 | 7.20 | 2.65 | 2.99 | 30.93 |
| Mean | 102.32 | 23.52 | 7.51 | 187.59 | 21.88 | 49.33 | 118.76 | 147.03 | 5.60 | 2.39 | 2.36 | 21.56 |
| SED | 2.55 | 1.39 | 0.62 | 21.40 | 0.85 | 2.59 | 2.71 | 5.40 | 0.11 | 0.05 | 0.06 | 1.56 |
| CV % | 3.05 | 7.26 | 10.22 | 14.36 | 4.77 | 6.44 | 2.80 | 4.50 | 2.49 | 2.67 | 3.19 | 8.89 |

Table 4 : Estimates of Variability, Heritability, Genetic advance and Genetic advance over per cent mean of parents $F_2$ populations of nine rice crosses.

| S.No. | Character | GCV | | PCV | | $h^2$ | | GA | | GA over per cent Mean | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Parents | $F_2$ | Parents | $F_2$ | Parents | $F_2$ | Parents | $F_2$ | Parents | $F_2$ |
| 1. | Plant height (cm) | 20.12 | 7.47 | 20.35 | 8.30 | 97.75 | 81.10 | 41.93 | 14.77 | 40.98 | 13.86 |
| 2. | Panicle length (cm) | 4.80 | 7.24 | 8.71 | 9.02 | 30.36 | 64.50 | 1.28 | 3.99 | 5.44 | 16.47 |
| 3. | No. of productive tillers / plant | 17.20 | 10.77 | 20.01 | 14.38 | 73.88 | 56.18 | 2.27 | 1.29 | 30.24 | 16.63 |
| 4. | Grains / Panicle | 28.32 | 16.84 | 31.75 | 24.10 | 79.54 | 48.84 | 94.98 | 39.76 | 52.02 | 24.25 |
| 5. | Plant dry matter (g) | 31.23 | 18.06 | 31.61 | 19.33 | 97.71 | 87.30 | 13.91 | 6.71 | 63.59 | 34.76 |
| 6. | Harvest Index | 8.69 | 4.02 | 10.82 | 8.71 | 64.50 | 21.36 | 7.09 | 1.81 | 14.37 | 3.83 |
| 7. | Days to 50 per cent flowering | 3.20 | 5.30 | 4.26 | 13.03 | 56.66 | 16.54 | 5.90 | 5.08 | 4.97 | 4.44 |
| 8. | Days to Maturity | 4.01 | 2.42 | 6.03 | 3.57 | 44.28 | 46.09 | 8.09 | 4.82 | 5.50 | 3.38 |
| 9. | Kernel length (mm) | 11.00 | 3.92 | 11.28 | 5.17 | 95.09 | 57.45 | 1.24 | 0.34 | 22.09 | 6.11 |
| 10. | Kernel breadth (mm) | 5.55 | 4.30 | 6.16 | 5.61 | 81.19 | 58.58 | 0.25 | 0.17 | 10.31 | 6.77 |
| 11. | L/B ratio | 13.43 | 6.97 | 13.81 | 9.51 | 94.64 | 53.78 | 0.64 | 0.24 | 26.91 | 10.56 |
| 12. | Grain yield per plant (g) | 31.42 | 10.23 | 32.65 | 15.99 | 92.58 | 40.91 | 13.43 | 2.31 | 62.27 | 13.48 |

PCV - Phenotypic Coefficient of variation (%)

GCV - Genotypic Coefficient of variation (%)

$h^2$ - Heritability in broad Sense (%)

GA - Genetic advance

## RESULTS AND DISCUSSION

The analysis of variance revealed highly significant differences among the parents and $F_2$ populations (Table 1) for all the characters studied except for panicle length in parents and for harvest index and days to 50 per cent flowering in $F_2$ populations.

According to Finkner *et al.*, (1973), the cross with high mean was relatively effective in identifying the superior segregants. In the present study the cross NLR 33648 / NLR 33891 for plant height, panicle length, plant dry matter, kernel length, L / B ratio and grain yield, cross CR 1009 / MTU 7014 for productive tillers per plant, days to maturiy and kernel breadth, cross CR 1009 / MTU 5249 for days to 50 per cent flowering and harvest index and cross CR 1009/ BPT 5204 for number of grains per panicle had higher mean values in $F_2$ population (Table 2). Among the parents (Table 3), NLR 9674 for days to maturity CR 1009 for kernel breadth, NLR 33648 for panicle length, grains per panicle and days to 50 per cent flowering, NLR 33641 for productive tillers per plant and harvest index, BCP 1 for plant height and plant dry matter, MTU 7014 for kernel length and L / B ratio and NLR 33891 for grain yield per plant possessed higher mean values. These crosses which registered higher mean values for more than one trait offer more scope for selecting superior segregants in their respective progenies.

In parental lines (Table 4), high GCV and PCV values were observed for plant height (20.12 and 20.35), grains per panicle (28.32 and 31.75), plant dry matter (31.23 and 31.61) and grain yield per plant (31.42 and 32.65) indicating the presence of ample variation for these characters in the present material. Similar results were reported by Anand kumar (1992) per plant height, Loka prakash *et al.*, (1992) for grains per panicle and Ganesan and Subramanian (1994) for plant dry matter and grain yield per plant. The cross with high *GCV* and *PCV* would be an useful estimate for assessing the relative variability among segregating population. In $F_2$, moderate to high *GCV* and *PCV* values were observed for productive tillers per plant (10.77 and 14.38), grains per panicle (16.84 and 24.10), plant dry matter (18.06 and 19.33) and grain yield per plant (10.23 and 15.99) indicating the presence of sufficient variation for these characters in the present material. Similar results were also reported by Ganesan *et al.*, (1996) in $F_2$ and $F_3$ populations.

Estimates of heritability and genetic advance were high for plant height (97.75 and 41.93) and number of grains per panicle (79.54 and 94.98) in parents indicating the predominance of additive gene action for these traits, enabling ease of selection. These findings are in agreement with Marimuthy *et al.*, (1990) for plant height and grains per panicle. In $F_2$ population plant height alone was under additive gene action. High heritability coupled with low to moderate genetic advance was recorded for plant dry matter (97.71 and 13.91) and grain yield (92.58 and 13.43) in parents and for plant height (81.10 and 14.27) and plant dry matter (87.30 and 6.71) in $F_2$ population indicating the presence of both additive and non - additive gene action. Similar results were reported by Murthy *et al.*, (1999) for plant dry matter and grain yield per plant and Chauhan *et al.*, (1990) for plant height. Low heritability coupled with low genetic advance was recorded for panicle length (30.36 and 1.28) in parents and for harvest index (21.36 and 1.81) and days to 50 per cent flowering (16.54 and 5.08) in $F_2$ generation indicated that these characters are highly influenced by environmental effects and selection for these characters would be ineffective. Similar results were also reported by Deosarkar *et al.*, (1989) for panicle length and Chaubey and Richharia (1993) for harvest index.

From the above findings it can be concluded that the characters plant height, grains per panicle and grain yield per plant in the parents, plant dry matter and plant height in $F_2$ populations exhibited high to moderate *GCV*, high heritability and genetic advance. The characters plant height, grains per panicle and grain yield per plant may be considered as important criteria for selection of the parents for hybridization programme and the characters plant dry matter and plant height considered in selecting the segregants in $F_2$ for further advancement to $F_3$ families.

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(Received on 8-10-2001 and revised on 10-4-2002)

The Andhra Agric. J. 49 (3&4) : 313 - 317 , 2002

# Hydraulic Conductivity Determination in Upper Krishna Project Command Area, Karnataka

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## ABSTRACT

The successful design and functioning of subsurface drains depends on the accurate and reliable estimation of K, as all the drain spacing equations invariably make use of this parameters. The hydraulic conductivity measurement studies were carried out in black soils (vertisols) with high clay content (43-72 per cent) underlain by bedded porous limestone located in high seepage zone of the Narayanpur Left Bank Canal Command of UKP. In situ K measurements were made using Posthole Auger Method in the Operational Research Project (ORP) site on 150 x 150 m grid basis. The K values varied from 0.07 to 0.18 m/d. The geometric mean of point measurements of K was 0.1 m/d. The geometric mean of areal hydraulic conductivity values ($K_a$) was 0.268 m/d. The higher $K_a$ values than the point measurements were in line with the reported literature. Further, the larger Ka values were also due to higher drain discharge in the area. Since areal measurements from drain discharges represent larger areas, they are more realistic than the point measurements.

**Key Words :** Hydraulic, Conductivitu, Determination, Upper Krishna Project.

Hydraulic conductivity (K) of the soils is a very important characteristic in relation to subsurface drainage of agricultural lands. The design and functioning of the subsurface drainage systems depends to a great extent on the accurate and reliable determination of K. It is because that in all the drain spacing equations invariably K is made use of. There are various methods to estimate K and the selection of a particular method depends on the practical applicability. Generally, the Auger Hole Method (a real measurement of K) is widely employed. While the Auger Hole Method is based on the rate of rise or fall of the water in an Auger Hole, the drain out flow method use the drain discharge (q) - water table (h) relation. Studies on measurement of K were carried out for drainage investigations under Indo-Dutch Network Operational Research Project (IDNORP) on "Drainage and Water Management for Salinity Control in Canal Commands" by the University of Agricultural Sciences, Dharwad in Upper Krishna Project (UKP) Command Area, Karnataka. The results of studies are presented and discussed in this paper.

Hooghoudt (1936) developed an empirical equation relating hydraulic conductivity to the rate of rise of the water level in a bailed out auger hole, which was subsequently redefined by Kirkham and Van Bavel (1948) and Ernst (1950). The most effective way to measure K-value for drainage design would be to install a drain and calculate K from the data on drain discharge and watertable position (Hoffman and Schwab, 1964). Studies comparing K-values determined from the Auger Hole Method with values determined from subsurface drains had shown that the Auger Hole Method was sufficiently reliable in relatively homogeneous soils (Talsma and Hoskew, 1959). El-Mowelhi and Van Schilfgaarde (1982) reported that K from the actual measurements of q and h resulted in higher values than those obtained by the auger hole method. Similar observations were made by Holsambre *et al.* (1991). In determining K-values by q-h relations using appropriate drainage formula, random deviations of the observations from the theoretical relationship frequently occur and are accompanied by a statistical confidence analysis (Oosterbaan and Nijiland, 1994). The large scale methods facilitate determination of overall K for the area of operation with the variation much less than that of the *in situ* small scale methods and therefore can be used directly in the drainage formula.

## MATERIAL AND METHODS

The study area falls under Narayanpur Left Bank Canal (NLBC) command of the Upper Krishna Project (The UKP is an ongoing major irrigation project aimed to command area of 1 M ha on full development and the present potential created is 2.86 lakh ha). The study area is located in between 16°28'1" - 16°30'0" N latitude and 76°27'19" - 76°30'25" E longitude. The elevation of the study area is 443 - 473 m above the mean sea level. The soils of the study area are deep to very deep black cotton soils with 44 - 47 clay per cent. The layout of drainage system adopted in the study area is depicted in the Fig. In the study area, out of 14.4 ha area, eleven 50 m spacing drains were installed in 12.7 ha and in the remaining 1.7 ha area, four drains with 30 m spacing were installed.

After installation of drains, the K was measured by the post hole Auger Hole Method on 150 x 150 m grid and subjected to statistical analysis. The q-h data was obtained by monitoring the drain discharge in the outlets and the depth to watertable in observation wells installed in between the drains. The Arithmetic and Geometric means as wells as 90 per cent confidence limits of areal K were estimated for the pipe drained area assuming the flow above the drain level only. The point and the areal measurements were compared and discussed in this paper.

## RESULTS AND DISCUSSION

The point hole measurements of hydraulic conductivity (K) were determined by Auger Hole Method and compared with those of pre-drainage situation in Table 1. The results showed that in most of the grids, the K-values increased. The hydraulic conductivity values during post - drainage varied from 0.07 to 0.18 m/d. The highest and lowest hydraulic conductivity values were recorded at grids C-7 and C-6 respectively.

Table 1 : Hydraulic conductivity of soils (m/d) at various grid points in the study area

| | Grids | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Situation | B-9 | C-6 | C-7 | D-7 | D-8 | E-6 | E-7 | E-8 | Geometric Mean |
| Pre - drainage* | 0.04 | 0.03 | 0.08 | 0.60 | 0.15 | 0.17 | 0.05 | 0.07 | 0.09 |
| Post - drainage | 0.15 | 0.07 | 0.18 | 0.08 | 0.07 | 0.15 | 0.10 | 0.07 | 0.10 |

(* Source : Balakrishnan *et al.* 1999)

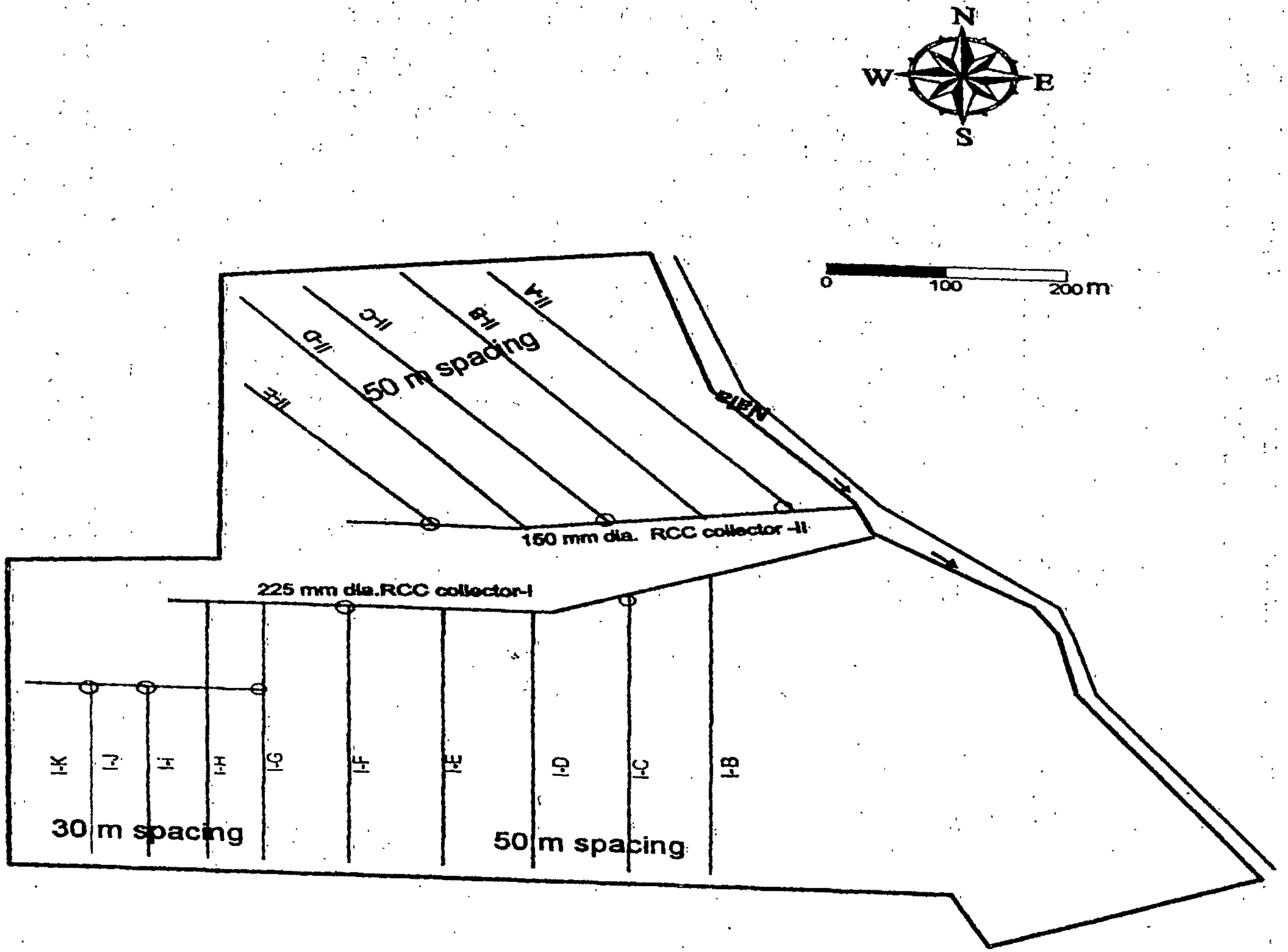

Fig. 1 Layout of the Drainage System in the Study Area

Table 2 : Areal hydraulic conductivity in the pipe drainage system (m/d)

| Between pipe drains | Range | Arithmetic mean | Geometric mean | Standard error | 90 per cent confidence limits |
|---|---|---|---|---|---|
| **30 m spacing** | | | | | |
| I - I and I - J | 0.063 - 0.639 | 0.318 | 0.284 | 0.146 | 0.272 < K < 0.363 |
| **50 m spacing** | | | | | |
| I - C and I - B | 0.234 - 0.318 | 0.276 | 0.252 | 0.059 | 0.245 < K < 0.291 |
| Average | 0.148 - 0.478 | 0.297 | 0.268 | | 0.258 < K < 0.327 |

The geometric mean of K values during pre-drainage in the study area was 0.09 m/d (Balakrishnan *et al.* 1999). Perusal of the results indicated that the K in the study area improved after the drain installation. At some of the grid points the K-value was almost doubled. On an average, 11 per cent increase in the Geometric mean of K-value was observed in the post - drainage scenario. The increase is attributed to proper drainage of the soils leading to increase in biological activities and reduction of soil sodicity. Moreover, the transformation of fallow lands into cultivable lands resulted in loosening of the topsoil and improvement of its tilth.

## Areal hydraulic conductivity measurements

The areal hydraulic conductivity ($K_a$) of the soils in the study area was estimated by following procedure - II (Ritzema, 1994). The areal hydraulic conductivity estimates were made between I - I and I - J laterals (30 m drain spacing) and I-C and I - B laterals (50 m drain spacing). The $K_a$ values were found to vary from 0.06 and 0.63 m/d. The arithmetic and geometric mean values between I - I and I - J laterals were 0.31 and 0.28 m/d respectively (Table 2). Between I-C and I-B laterals, the Arithmetic and Geometric mean values were 0.27 and 0.25m/d respectively. Further analysis of the results revealed that 90 per cent confidence limits of the $K_a$ values between the 30 and 50 m drain spacings varied from 0.272 to 0.363 m/d and 0.245 to 0.291 m/d respectively. The overall $K_a$ values ranged from 0.258 to 0.327m/d.

It is interesting to note that the areal estimates of hydraulic conductivity (Ka) values obtained by the drain outflow method were nearly three times greater than that of the point measurements of hydraulic conductivity by the Post Hole Auger Method is in agreement with the findings of E1-Mowelhi and Van Schilfgaarde (1982) Holsambre *et al.* (1982) and Suryawanshi *et al.* (1991) and is because the K value determined by Auger Hole Method represents the small area (soil column) whereas in drain outflow method the hydraulic conductivity estimate represents the larger area. Also the flow through the stratified limestone substrata is similar to that of finger / preferential flow. It can be inferred that the areal estimates of hydraulic conductivity are more reliable than point measurements.

## ACKNOLEDGEMENT

The authors gratefully acknowledge the support received from the Indo-Dutch Net work Project, Bheemerayanagudi, Gulbarga district for carrying out the above study.

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(Received on 22-4-2002 and revised on 14-6-2002)

The Andhra Agric. J. 49 (3&4) : 318 - 321, 2002

# Groundnut Productivity and Yield Gap Analysis of Groundnut Production

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## ABSTRACT

The present study revealed that the yield gap ranged from - 12.41 to 71.00 per cent with a mean value of 36.22 per cent between Front Line Demonstration plots and farmers fields under different categories viz; large, medium, small, and no yield gap groups. It was also observed that the 7.81 per cent of the respondents realized higher yield as compared to Front Line Demonstration plots, which clearly showed the potential productivity of groundnut under real farm situations. The results showed the wide scope to minimize the yield gap at least up to the extent of small yield gap (81.17 per cent of the potential yield) in groundnut production, if the efforts are made accordingly.

**Key Words :** Groundnut, yield gap, farmers fields, productivity.

The yield potential of varietys' is assessed by the plant breeders after having experimentation and various field trails. But the farmers do not get the same results as high as those obtained on research plots as well on demonstration plot. Since demonstrations are conducted on farmers' fields, it would be desirable to consider the demonstration yield as potential yield that can be obtained under farmers fields situations, instead of experimental station yield. In this study, the difference between yield obtained in Front Line Demonstration plots and those obtained by the farmers is considered as the yield gap.

Gujarat is a major groundnut producing state in the country. The Saurashtra region accounts for about 85 per cent of the total groundnut production of the state. However, the average productivity of groundnut in this region is very less 714 Kg ha$^{-1}$ as compared to 870 Kg ha$^{-1}$ state average and 855 Kg ha$^{-1}$ the country average. Moreover, as per the analysis done from the Front Line Demonstration results, the available techniques can increase the yield about 36.50 per cent. Although a number of new technologies for groundnut cultivation are being developed, even then there is a wide gap between yield harvested under the Front Line Demonstration plots and farmers fields. Therefore, there is a great scope for increasing the groundnut production even with existing technology. Hence, an attempt has been made to find out the yield gap in groundnut production as well as the potential productivity of groundnut crop under real farming situations.

## METHODOLOGY

The study was conducted in South Saurashtra Agro - Climatic Zone of Gujarat state. Out of total 24 talukas of this region 12 talukas were randomly selected for the study. A total number of 256 respondents were selected by proportionate random sampling method from the 24 villages ie. 2 villages from each selected

Table 1: Groundnut yield and per cent yield gap of the respondents

| Crop | Farmers yield (1997-98) | Frontline demonstrations plot yield | Per cent yield gap | Farmers yield (1998-99) | Frontline demonstrations plot yield | Per cent yield gap | Average of two years (1997-98, 1998-99) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Farmers yield | Frontline demonstrations plot yield | Per cent yield gap |
| Groundnut (*Kharif*) | 1186.02 | 2027.85 | 41.51 | 1204.31 | 1773.95 | 32.11 | 1195.16 | 1873.97 | 36.22 |

Table 2: Distribution of farmers according to their extent of yield gap n=256

| Sl. No. | Extent of yield gap | Year (1997-98) | | Year (1998-99) | | Average of two years (1997-98, 1998-99) | |
|---|---|---|---|---|---|---|---|
| | | Frequency | Per cent | Frequency | Per cent | Frequency | Per cent |
| 1 | Large yield gap (66.01% and above) | 50 | 19.53 | 51 | 19.92 | 33 | 12.89 |
| 2 | Medium yield gap (33.01 to 66.00%) | 119 | 46.49 | 110 | 42.97 | 114 | 44.53 |
| 3 | Small yield gap (up to 33.00%) | 68 | 26.56 | 78 | 30.47 | 89 | 34.77 |
| 4 | No yield gap (equal or more) | 19 | 7.42 | 17 | 6.64 | 20 | 7.81 |

talukas. To find out the yield gap two years data 1997-98 and 1998-99 of *kharif* groundnut yield were collected from the respondents as well as yield obtained in Front Line Demonstration plots during the same year recorded by the Department of Oilseed, Gujarat Agricultural University, Junagadh. The difference of the per cent yield gap between Front Line Demonstration and yield on the farmers field was computed with the help of following formula :

$$\text{Per cent Yield Gap} = \frac{\text{Average yield of FLD plots Kg ha}^{-1} - \text{Average yield Kg ha}^{-1} \text{ obtained by the farmers}}{\text{Average yield of FLD plots Kg ha}^{-1}} \times 100$$

Based on the per cent yield gap the farmers were grouped in to the following four categories :

1 Large yield gap group ----- 66.01% yield gap and above
2 Medium yield gap group ----- 33.01 to 66% yield gap
3 Small yield gap group ----- yield gap up to 33%
4 No yield gap group ----- yield equal or above the FLD plots

Moreover, on the basis of the highest yield obtained by the farmers under the group of no Yield gap will be considered as the potential productivity of groundnut under the real farming situations.

## RESULTS AND DISCUSSION

The data regarding yield gap of groundnut (Table 1) it is clear that on an average of 36.22 per cent yield gap was observed between Front line Demonstration yields and yield obtained by the farmers. This indicated that groundnut yield can be increased very easily by adoption of improved groundnut production technologies in an appropriate form.

Similarly the extent of yield gap was also studied and the respondents were grouped into four categories according to their extent of yield gap (Table 2) that a very limited number of farmers (7.81%) had no yield gap in average of both the years. The majority of the farmers

Table 3: Comparision of yield and yield gap per hectare of the different yield gap category

| Sl. No. | Yield gap category | Year 1997-98 | | | 1998-99 | | | Average of two years (1997-98, 1998-99) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total yield kg ha$^{-1}$ | Average yield kg ha$^{-1}$ | Average per cent of yield gap | Total yield kg ha$^{-1}$ | Average yield kg ha$^{-1}$ | Average per cent of yield gap | Total yield kg ha$^{-1}$ | Average yield kg ha$^{-1}$ | Average per cent of yield gap |
| 1 | Large yield gap (66.01 % and above) | 27731<br>(19.53%) | 554.62 | 72.65 | 27335<br>(19.92%) | 535.98 | 69.79 | 17895<br>(12.89%) | 542.27 | 71.06 |
| 2 | Medium yield gap (33.01 to 66.00%) | 122135<br>(46.49%) | 1026.34 | 49.39 | 116903<br>(42.97%) | 1062.75 | 40.09 | 110566<br>(44.53%) | 969.88 | 48.24 |
| 3 | Small yield gap (up to 33%) | 111133<br>(26.56%) | 1634.31 | 19.41 | 126630<br>(30.47%) | 1623.46 | 8.48 | 135372<br>(34.77%) | 1521.03 | 18.83 |
| 4 | No yield gap | 42622<br>(7.42%) | 2245.37 | -10.73 | 37435<br>(6.64 %) | 2202.06 | -24.13 | 42129<br>(7.81%) | 2106.45 | -12.41 |
| | Total | 303621 | 1186.02 | 41.51 | 308303 | 1204.31 | 32.11 | 305962 | 1195.16 | 36.22 |

Figures in parentheses shown are the per cent respondents of particular group.

(57.42%) had medium and large yield gaps. It was 66.02 per cent in the year of 1997 - 98 and 62.89 per cent in the year of 1998 - 99. On an average only 34.77 per cent farmers had small yield gap. However, yearwise, it was only 26.56 per cent and 30.47 per cent in 1997 - 98 and 1998-99, respectively.

An attempt was also made to study the comparison of yield and yield gap according to different yield gap groups viz. large, medium, small and no yield gap with respect to Frontline Demonstration plots yield (100%). The data (Table 3) clearly indicated that the average percentage of yield gap, in large yield gap category were 72.65, 69.79 and 71.06 for the year 1997-98, 1998-99 and average data, respectively. In case of medium yield gap category, the per cent yield gap were 49.39, 40.09 and 48.24 per cent for the years 1997-98, 1998-99 and average data respectively. Looking to the data of small yield gap category, the per cent yield gap were 19.41, 8.48 and 18.83 for the year 1997-98, 1998-99 and average of these two years respectively. Considering the no yield gap category the average per cent yield gap were -10.73, -24.13 and -12.41 per cent for the years 1997-98, 1998-99 and average data respectively.

From the above data, it could be inferred that majority (92.19%) of the respondents had yield gap ranging from 18.83 to 71.06 per cent. Thus, it clearly showed that the yield level of majority of the farmers can be increased and narrow down the yield gap very easily to the level of small yield gap group (81.17% of the potential yield), if the full opportunities for adopting improved technologies are provided and the major constraints should be addressed in an appropriate manner.

It was also observed during the investigation that a small group (7.81%) of the respondents was getting 12.41 per cent higher yield as compared to Frontline Demonstration plots yield, which clearly showed the potential productivity of groundnut in the real farm situations.

Therefore, it could be concluded that yield gap between the potential yield and yield obtained in the large yield gap groups (ranging - 12.41 to 71.06%) could be bridged on the farmers field. A great majority (92.19%) of the respondents had yield gap up to 71.06 per cent. Thus, the problem of low yield in groundnut is severe. It is also realized that 7.81 per cent of the respondents had no yield gap and they harvested 12.41 per cent higher yield as compared to Front Line Demonstration plots which clearly indicates there exist higher productivity potential of groundnut under real farming situations.

The higher realized yield by a few individual farmers clearly suggested that there exist a huge untapped yield potential even with existing technology that could be easily harnessed by the peasantry of this region. Hence, there is a wide scope to minimize the yield gap by streamlining the existing system for effective and efficient transfer of technologies to the direct reach of the farmers.

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(Received on 10-12-2001 and revised on 19-4-2002)

The Andhra Agric. J. 49 (3&4) : 322 - 329 , 2002

# Perceptions of Farmers about ANGRAU Farm Advisory System Through DAATT Centres

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## ABSTRACT

The present study aimed at finding out farmers perceptions about ANGRAU farm advisory system through DAATT Centres. A majority of the respondents were found to be of middle aged, primary education, small land holdings with medium mass media exposure and extension contact. Majority of the farmers had medium perception towards ANGRAU DAATT Centres. The Chi square analysis revealed that education, mass media exposure, extension contact had significant influence upon perceptions of the farmers, whereas age and land holding had no significant influence.

**Key Words :** Perceptions, DAATT Centres, sustainable agriculture.

Sustainable agriculture is the key for development of Indian agriculture. Accomplishment in getting good results of agricultural research and their transmission is easily practicable forms to the farmers is desirable in fulfilling the targets. Research and extension should complement each other to go ahead in desired direction. The technological innovations in agriculture generated by various agricultural universities and national and international institutes must reach the tillers of the soil.

In order to give technical support to farmers and line departments like Agriculture, Horticulture, Marketing, etc., the ANGRAU has reorganized its extension service through "District Agriculture Advisory and Transfer of Technology Centres" located at head quarters of each district of the state with multi-discipline scientist team during 1998. Under this backdrop a study was conducted to find out the perceptions of farmers about ANGRAU farm advisory system through DAATT Centres and to find out the influence of personal, socio-economic and situational characteristics of farmers on their perception towards DAATT Centres.

## METHODOLOGY

The present study was conducted in three purposively selected districts of Krishna - Godavari zone of Andhra Pradesh viz Guntur, Krishna and West Godavari, keeping in view the following criteria: these three districts contribute lions share of agricultural production in Andhra Pradesh. More over 60 per cent of ANGRAU research stations are located in these districts. Fixed number of 20 farmers from each district were selected randomly after taking the list of farmers who have continuous association with DAATT Centre and Agricultural Market Committee programmes to make a sample of 60 farmers from Krishna - Godavari zone.

A pre-tested interview schedule was used for data collection through personal interview in local language and the obtained data was tabulated and analyzed with the help of Mean, Standard Deviation and Chi Square test for interpretation.

## Perception

Perception can be regarded as a meaningful sensation. Perception organization is dependent upon the characteristics of stimuli object such as nearness, likeness, inclusiveness and part or whole relationship (Dahama and Bhatnagar, 1985). Here it is operationally defined as awareness and mental image of the farmers about ANGRAU District Agricultural Advisory and Transfer of Technology Centres.

To measure the perception, statements were prepared referring to the available documents, using the semistructured interview in non sample area. After refining it through pre testing, a structured interview schedule was prepared by keeping these statements under 11 indicators. In all 54 statements were prepared farmers responses were elicited over 'Agree' and 'Disagree' continuum.

| Response | Score |
|---|---|
| Agree | 2 |
| Disagree | 1 |

After eliciting the responses, frequency and percentages were calculated. The respondents were also categorized in three groups i.e., low perception, medium perception and high perception based on mean and standard deviation. The minimum possible score is 54 and maximum possible score is 108. The respondents were categorized by using mean and standard deviation as a measure of check as described hereunder.

| Total Score | Category of Perception |
|---|---|
| Less than Mean - S.D. | Low |
| Between Mean ± S.D. | Medium |
| More than Mean + S.D. | High |

To study the perceptual differences of farmers, some important personal, socio-economic and situational characteristics of farmers were taken within the boundaries of exploratory design and their influence was studied.

## Age

Age of the respondents was measured as revealed by respondents themselves in completed years at the time of inquiry. For categorisation of respondents over age, the norms of maximum admissible age for members in youth club or Government service i.e., 35 years and the superannuation age for retirement in the Government organization, 58 years have been taken as guidelines (Venkataramaiah, 1983).

| Cateory | Age |
|---|---|
| Young age | Below 35 years |
| Middle age | 35 - 58 years |
| Old age | Above 58 years |

## Education

Each farmer interviewed in the study was appealed to indicate the number of schooling or his self - designated literacy acquired in formal learning situation. Based on the information, the farmers were categorised into six groups, namely (i) illiterate. (ii) literate, (iii) primary school, (iv) middle school, (v) high school and (vi) collegiate education.

For the purpose of analysis, two groups were formed as under (i) illiterate and (ii) literate (primary or middle or high school or college education).

### Land Holding

This was operationalised as the number of standard score possessed by the farmers at the time of inquiry. The farm size of a farmer was arrived by converting the dryland and irrigated land into standard scores as 2.5 acres of dryland or one acre of irrigated land equivalent to one standard score. Based on the standard score, the respondents were categorised into three categories, namely marginal, small and high farmers as per the Andhra Pradesh Land Ceiling Act, 1973.

### Mass Media Exposure

Mass media exposure was operationalised as the extent of exposure of respondents to the mass media such as radio, newspaper, readings from magazines, reading books, television and training programme.

This was quantified by using the scale developed by John Knight (1973). The scoring was done based on the frequency of exposure to different items. The respondents were categorised into three groups based on the mean and standard deviation i.e., those with high mass media exposure (> Mean + S.D.), medium mass media exposure (Mean ± S.D.) and low mass media exposure (< Mean - S.D.).

Extension Contact

Extension contact was operationalised as the degree to which an individual maintained contact with formal organisations like agriculture and allied enterprises. It was quantified as per the measurement developed by Ponnappan (1982). It was quantified based on the scores assigned as follows:

| Frequency of Contact | Score |
|---|---|
| Frequently | 3 |
| Sometimes | 2 |
| Rarely | 1 |

| Purpose of Contact | Score |
|---|---|
| Agriculture | 2 |
| Non-agriculture | 1 |

The scores on frequency of contact and purpose of contact for each change agent were summed upto arrive at the total score of individual respondent

Based on the total score obtained by the respondents they were grouped into three categories on the basis of mean and standard deviation, i.e., those with high extension contact (> Mean + S.D.), medium extension contact (Mean ± S.D.) and low extension contact (< Mean - S.D.).

## RESULTS AND DISCUSSION

The results of present study were discussed in the following sub-heads.

1. Perceptions of farmers about ANGRAU farm advisory system through DAATT Centres.
2. Influence of personal, socio-economic and situational factors on their perception towards DAATT Centres.

### Age and Perception

From the Table 3 it could be observed that irrespective of their age, the farmers had the same perception towards the DAATT centres resulting same kind of information transfer to all the groups. This finding gets support of Reddy and Reddy (1977).

## Perceptions of farmers about ANGRAU farm advisory System Through DAATT centres :

Table 1: Distribution of respondents according to their perception about DAATT centres . (n = 60)

| S.No. | Statement (1) | Agree (2) | Disagree (3) |
|---|---|---|---|
| **I** | **LOCATION** | | |
| 1 | It is easily approachable | 31(51.66) | 29(48.34) |
| 2 | It is centrally located | 26(43.33) | 34(56.66) |
| **II** | **BUILDINGS** | | |
| 3 | Buildings are spacious with training hall | 13(21.66) | 47(78.33) |
| 4 | Taking care of scientists requirements | 14(23.33) | 46(76.66) |
| 5 | There is provision for boarding and lodging | 17(28.33) | 43(71.66) |
| 6 | There is room for exhibition | 22(36.66) | 38(63.33) |
| 7 | There is room for farmer scientist interaction | 14(23.33) | 46(76.66) |
| 8 | There is room for observation | 16(26.66) | 44(73.33) |
| **III** | **STAFFING** | | |
| 9 | Staff provided were with adequate field experience | 33(55.00) | 27(45.00) |
| 10 | Staffing is adequate | 20(33.34) | 40(66.66) |
| 11 | Staffing is accordance with needs of farmers. | 19(31.67) | 41(60.33) |
| 12 | Staff with technical competency | 25(41.67) | 35(58.33) |
| **IV** | **EXPERTISE** | | |
| 13 | Expertise provided is timely | 38(63.33) | 22(36.67) |
| 14 | Expertise provided is adequate | 24(40.00) | 36(60.00) |
| 15 | Expertise extended is situational | 33(55.00) | 27(45.00) |
| 16 | Expertise extended is pratical | 42(70.00) | 18(30.00) |
| 17 | Expertise provided is cheap from the point of implementation | 34(56.67) | 26(43.33) |
| 18 | Expertise extended is essential to understand | 45(75.00) | 15(25.00) |
| **V** | **ASSESSMENT AND REFINEMENT OF TECHNOLOGY** | | |
| 19 | Adaptive trials and demonstrations conducted for assessment and refinement are situational | 31(51.66) | 29(48.34) |
| 20 | Adaptive trails and demonstrations are mandatory | 27(45.00) | 15(25.00) |
| 21 | Adaptive trails and demonstrations are adequate | 23(38.33) | 37(61.67) |
| 22 | Adaptive trials and demonstrations are timely | 33(55.00) | 27(45.00) |
| 23 | Surveys conducted for technology identification are adequate | 24(40.00) | 36(60.00) |
| **VI** | **DATABASE** | | |
| 24 | Database with DAATTC is situational | 35(58.33) | 25(41.67) |
| 25 | Database with DAATTC is adequate | 27(45.00) | 33(55.00) |
| 26 | Database created at DAATTC is timely | 31(51.66) | 29(48.33) |
| 27 | Problems identified as part of database creation are pertinent | 26(43.33) | 34(56.66) |
| 28 | Potentialities identified as part of database creation are factual | 34(56.66) | 26(43.33) |
| 29 | Action plans developed are practical and pragmatic | 31(51.66) | 29(48.32) |

| | (1) | (2) | (3) |
|---|---|---|---|
| **VII** | **DIAGNOSTIC VISITS AND JOINT FIELD VISITS** | | |
| 30 | Diagnostic visits are in accordance with needs of farmers | 40(66.66) | 20(33.34) |
| 31 | Diagnostic visits and field visits are well coordinated | 32(53.33) | 28(46.67) |
| 32 | Diagnostic visits and field visits are adequate | 25(41.66) | 35(58.34) |
| 33 | Diagnostic visits and joint field visits are timely | 29(48.33) | 31(51.67) |
| 34 | Diagnostic visits and joint field visits are effective | 32(53.34) | 28(46.66) |
| 35 | Diagnostic visits and joint field visits are location specific | 36(60.00) | 24(40.00) |
| 36 | Diagnostic visits and joint field visits are appropriately done | 38(63.34) | 22(36.66) |
| **VIII** | **KISAN MELAS** | | |
| 37 | Role of scientists at kisan melas of state department of agriculture is appropriate and adequate | 48(80.00) | 12(20.00) |
| 38 | Knowledge provided by scientists of DAATT centre at kisan melas is practicable | 51(85.00) | 9(15.00) |
| 39 | Minikits provided by DAATT centre scientists at kisan melas are adequate | 17(28.34) | 43(71.67) |
| **IX** | **EXTENSION METHODS** | | |
| 40 | Group discussions / meetings conducted by DAATT centre are need based | 49(81.66) | 11(18.34) |
| 41 | Group discussion / meetings conducted by DAATT centre are adequate | 33(55.00) | 27(45.00) |
| 42 | Group discussion / meetings conducted by DAATT centre are timely | 47(78.33) | 13(21.67) |
| 43 | Group discussion / meetings conducted by DAATT centre are problem solving in nature | 44(73.33) | 16(26.67) |
| 44 | Extension methods and aids used by DAATT centre are effective | 49(81.67) | 11(18.33) |
| **X** | **INFORMATION CENTRE** | | |
| 45 | Information centre maintained at DAATT centres is farmers friendly | 30(50.00) | 30(50.00) |
| 46 | Information centre is modern and well equipped with real objects and exhibits | 17(28.33) | 43(71.67) |
| 47 | Real objects and specimens displayed are adequate | 19(31.66) | 41(68.34) |
| **XI** | **INFORMATION MATERIAL** | | |
| 48 | Information material developed by DAATT centre are need based | 45(75.00) | 15(25.00) |
| 49 | Information material developed are timely | 28(46.66) | 32(53.34) |
| 50 | Information material developed by DAATT centre are relevant from point of content | 56(93.33) | 14(6.67) |
| 51 | Cost of information material sold by DAATT centre are permissive | 47(78.34) | 13(21.66) |
| **XII** | **MASS MEDIA PARTICIPATION** | | |
| 52 | Mass media participation of DAATT centre scientists in providing need based agricultural information is adequate | 32(53.34) | 28(46.66) |
| 53 | Mass media participation is timely | 32(53.34) | 28(46.66) |
| 54 | Mass media participation is need based | 28(46.66) | 32(53.34) |
| | Mean (X) = 81.60 S.D. (σ) = 7.79 | | |

Majority (50.00%) of the respondents had medium perception followed by low (41.66%) and high (8.34%) perception towards ANGRAU DAATT Centres (Table 2).

Recency of ANGRAU DAATT Centres establishment with little infrastructural facilities and staff and under streamlined policy framework might be the reason for the medium to low perception of farmers towards DAATT centres.

Table 2: Distribution of farmers according to their perception category.

| S.No. | Category | Frequency | Percentage |
|---|---|---|---|
| 1 | Low perception (< mean - S.D.) | 25 | 41.66 |
| 2 | Medium perception (mean ± S.D.) | 30 | 50.00 |
| 3 | High percepion (> mean + S.D.) | 5 | 8.34 |
| | Total | 60 | 100.00 |

Mean (X) = 81.60 S.D. (σ) = 7.79

## Influence of personal, socio-economic and situational characteristics on their perception towards DAATT Centres :

Table 3: Influence of age of the farmers on their perception about the DAATT centres n = 60

| S.No. | Age | Low | | Medium | | High | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | Frequency | % | Frequency | % | Frequency | % | Frequency | % |
| 1 | Young | 5 | 41.67 | 6 | 50.00 | 1 | 8.33 | 12 | 20.00 |
| 2 | Middle | 17 | 48.57 | 15 | 42.86 | 3 | 8.57 | 35 | 58.53 |
| 3 | Old | 3 | 23.07 | 9 | 69.24 | 1 | 7.69 | 13 | 21.67 |
| | Total | 25 | 41.67 | 30 | 50.00 | 5 | 8.33 | 60 | 100.00 |

$X^2_{cal}$ = 5.807 non - significant at 4 df, 5 per cent level of probability
Perception is independent of age of the farmers.

Table 4: Influence of education of the farmers on their perception about the DAATT centres
Perception about the DAATT centres (n = 60)

| S.No. | Education | Low | | Medium | | High | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | Frequency | % | Frequency | % | Frequency | % | Frequency | % |
| 1 | Illiterate | 9 | 75.00 | 2 | 16.67 | 1 | 8.33 | 12 | 20.00 |
| 2 | Literate | 16 | 33.33 | 28 | 58.34 | 4 | 8.33 | 48 | 80.00 |
| | Total | 25 | 41.67 | 30 | 50.00 | 5 | 8.33 | 60 | 100.00 |

$X^2_{cal}$ = 7.26 significant at 2 df, 5 per cent level of probability
Perception is dependent upon education of the farmers.

Table 5: Influence of land holding of the farmers on their perception about the DAATT centres
Perception about the DAATT centres (n = 60)

| S.No. | Land Holdings | Low | | Medium | | High | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | Frequency | % | Frequency | % | Frequency | % | Frequency | % |
| 1 | Marginal | 10 | 38.47 | 14 | 53.84 | 2 | 7.69 | 26 | 43.33 |
| 2 | Small | 15 | 50.00 | 13 | 43.33 | 2 | 6.67 | 30 | 50.00 |
| 3 | Big | 0 | 0.00 | 3 | 75.00 | 1 | 25.00 | 4 | 6.67 |
| | Total | 25 | 41.67 | 30 | 50.00 | 5 | 8.33 | 60 | 100.00 |

$X^2_{cal}$ = 5.55 non - significant at 4 df, 5 per cent level of probability
Perception is dependent upon land holding of the farmers.

Table 6: Influence of mass media exposure of the farmers on their perception about the DAATT centres
Perception about the DAATT centres (n = 60)

| S.No. | Mass Media Exposure | Low | | Medium | | High | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | Frequency | % | Frequency | % | Frequency | % | Frequency | % |
| 1 | Low | 8 | 88.89 | 1 | 11.11 | 0 | 0.00 | 9 | 15.00 |
| 2 | Medium | 12 | 34.29 | 20 | 57.14 | 3 | 8.57 | 35 | 58.33 |
| 3 | High | 5 | 31.25 | 9 | 56.25 | 2 | 12.50 | 16 | 26.67 |
| | Total | 25 | 41.67 | 30 | 50.00 | 5 | 8.33 | 60 | 100.00 |

$X^2_{cal}$ = 9.945 significant at 4 df, 5 per cent level of probability Perception is dependent upon mass media of the farmers.

Table 7: Influence of mass media exposure of the farmers on their perception about the DAATT centres
Perception about the DAATT centres (n = 60)

| S.No. | Mass Media Exposure | Low | | Medium | | High | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | Frequency | % | Frequency | % | Frequency | % | Frequency | % |
| 1 | Low | 7 | 70.00 | 3 | 30.00 | 0 | 0 | 10 | 16.66 |
| 2 | Medium | 16 | 47.05 | 17 | 50.00 | 1 | 2.95 | 34 | 56.67 |
| 3 | High | 2 | 12.50 | 10 | 62.50 | 4 | 25.00 | 16 | 26.67 |
| | Total | 25 | 41.66 | 30 | 50.00 | 5 | 8.33 | 60 | 100.00 |

$X^2_{cal}$ = 13.27 significant at 4 df, 5 per cent level of probability

Perception is dependent upon extension contact of the farmers.

## Education and Perception

The results of Table 4 revealed that the education has significant relationship with the perception of farmers towards functioning of DAATT centres. This result was in conformity with the findings of Subbaiah (1988) and Raju Naik *et al* (1994). And this finding is not in conformity with those of Reddy and Reddy (1977), and Hullatti and Dudhani (1989).

## Land Holding and Perception

Results presented in Table 5 indicated that farm size of the farmers do not have any significant relation with their perception towards the functioning of the DAATT centres. This may be due to the awareness of the technology extended to all, irrespective of their land holding size. This results tune with the findings of Reddy and Reddy (1997) and Srinu (1997).

## Mass Media Exposure and Perception

Table 6 clearly shows that there is significant relationship between perception of the farmers about ANGRAU DAATT centres and their mass media exposure. This finding is in line with those of Ratnasree (1992) and Suresh (1994). This result is not in conformity with the finding of Srinu (1977).

## Extension Contact and Perception

Table 7 indicated that there is relationship between perception of farmers about ANGRAU DAATT Centres and their extension contact. This may be due to the case in understanding in perception process through the extension contact earlier established. This binding gets support from those of suresh (1994) and Srinu (1997).

It can be concluded that a majoriy of the respondents were found to be of middle aged, primary education, small land holdings with medium mass media exposure and extension contact. Majority of the farmers had medium perception towards ANGRAU DAATT Centres. The Chi square analysis revealed that education, mass media exposure, extension contact had significant influence upon perceptions of the farmers, whereas age and land holding had no significant influence.

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(Received on 2-7-2001 and revised on 21-11-2001)

The Andhra Agric. J. 49 (3&4) : 330 - 333, 2002

# Folk Beliefs Associated With Crop Production Among Koyas

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## ABSTRACT

The study revealed that majority of the farmers adhered to the existing folk beliefs among Koyas. Based on the study, it is recommended that the spread of civilization and modernization has been checked by the numerous hills and plateaus in the area. The priest was dominating the score in remote areas due to his knowledge about herbal plants used in the treatment of human beings as well as the animals. The developmental agents must try to build up rapport with the priest acquire knowledge of various herbal medicines, which may be useful to human as well as livestock. Efforts are needed to educate the tribals including their beliefs, in changing their attitude / favourable towards dairy farming and in exposing them to various communication sources and institution operating in the area.

**Key Words :** Folk Beliefs, Crop Production, Deities of God, Traditional Beliefs.

The tribals have tried to understand and adjust themselves with the supernatural world, which they believed is infested with many a spirit of varied nature and potentialities. A few of these spirits are considered benevolent while others are malevolent. Some of them have been attributed to the status of deities of God. They believed that elaborate worship and observance of rituals bring success and ward off misfortunes and calamities. Besides this, they think that this world is full of praying witches and other spirits, which are seen to do harm to human beings as well as their crops. The prolonged interaction with Hindu culture has also influenced them. The Hindu idea of heaven, hell and doctrine of 'karma' and 'Soul' is commonly in vogue amongst them. Thus, in their traditional ways of life, which are now under a process of adjustment, tribals are generally steeped with lots of superstitious and primitive beliefs. They have some such beliefs pertaining to crop production. There are several studies to support those socio-economic factors and within that folk beliefs play a vital role in deciding the suitability of a technology and also its transfer. Here only superstitious beliefs pertaining to crops have been considered, as these need to be changed if we expect any dairy development programme to be successful in the area. While analysing and discussing such beliefs, tribal farmers own rationale and as far as possible scientific or logical rationale for such beliefs has been provided. Out of 33 Schedule Tribal groups of Andhra Pradesh, koya is the predominant tribal group with unique culture concentrated in the boarder area of Khammam, East Godavari and West Godavari districts of Andhra Pradesh. With this background the present study was organized to analyze the folk beliefs associated with crop production among Koyas.

## METHODOLOGY

This study was conducted purposively selected in West Godavari district of coastal Andhra Pradesh. Out of 46 mandals of the district, 3 mandals (Jeelugumilli, Polavaram and Buttayagudem) were purposely selected, where koyas are predominantly inhabitated. Two villages from each of selected 3 mandals i.e., total 6 villages (Bothappa Gudem, Puchika Padu, Kondrukota, Chilakaluru, Cheemalavari Gudem and Doramamidi) were selected. Fifteen farmers from each village i.e., total 90 farmers, 30 each from small, medium and large categories were selected on the basis of herd size. To study the superstitious and primitive beliefs pertaining to crops, the researcher collected a list of such beliefs in consultation with elderly tribals of the study area, educationists. Social workers of Integrated Tribal Development Agency (ITDA), K.R. Puram. With the help of a schedule developed for the purpose, an effort was made to ascertain how many of these beliefs are held by the tribal farmers of three mandals under study. The beliefs were rank ordered after analysis.

The data were collected through an interview schedule on various aspects of study. The tribal farmers were individually interviewed and personal observations were also made. The data were analysed using Statistical Package for Social Sciences (SPSS). Descriptive statistics (frequency tables, simple percentage) and simple ranking were used to analyze the data.

## RESULTS AND DISCUSSION

### Folk beliefs associated with crop production

### 1. Before ploughing the field, they worship the plough and ploughman for better starting

It was found that all of the respondents had faith in this belief and they assigned first rank to this. It is almost a way of life there. The tribals however did not given any satisfactory answer except that their ancestors followed it. The ploughman is worshipped to motivate him for better performance and the plough is worshipped to check its physical condition/ maintenance. This shows the importance of implements in agriculture, which is only a faith.

### 2. While going to plough the field on the first day in monsoon and if there is sight of a widow, then it is considered as hard indication for starting of ploughing of fields

This belief is held by two thirds of the tribal farmers. When farmers were asked to enlist causes associated with this, they failed to do so. Scientifically, there is no base and this belief does not hold any truth. In reality, sight of such person never affects the performance of farmer's crops. But, psychologically the farmer may take it negatively, which may retard his activeness and concentration.

### 3. Worshipping of all unripened crops, fruits and animals on the occasion of any festivals for the well being of the family

Nearly 90 per cent of the tribal farmers had this belief. There is no special reason, but they followed their ancestors. But, we can say that before 'Deepawali', unripened fruits are not used with the plea reasons. This results in saving of such crops at young stage resulting in higher production.

### 4. Seeds should not be given to anybody till own sowing is over, otherwise the farmer gets low yield

In the context of this belief, about 47 per cent of the farmers (respondents) told that they were adhering to this. They were following this because their forefathers followed it . However, they could not give any satisfactory reason associated with this. One possible reason behind this might be that it has got assimilated with culture of the tribals.

### 5. High yield entirely depends upon God's will rather than use of improved seeds of fertilizers

Table 1. Folk beliefs (superstitions) held by dairy farmers regarding crop production practices

| Sl. No. | Folk beliefs | Frequency | Percenage | Rank |
|---|---|---|---|---|
| 1 | Before ploughing of the field, they worship the plough and plough man for better starting | 90 | 99.99 | I |
| 2 | Sacrificing fowl before sowing and harvesting operations influences the yield | 82 | 91.02 | II |
| 3 | Worshipping of all the unripened crops, fruits and animals on the occasion of any festivals for the well being of the family | 80 | 88.80 | III |
| 4 | In the beginning of the agricultural season cow is sacrificed. Rice grains are soaked in a blood and broadcast over the cultivating fields. This improves the agricultural yield | 76 | 84.36 | IV |
| 5 | Worshipping of the God for rain | 72 | 79.92 | V |
| 6 | While going to plough the field on the first day in monsoon and if there is a sight of a widow, then it is considered as a bad indication for starting of ploughing of fields | 59 | 65.49 | VI |
| 7 | High yield entirely depends upon God's will rather than use of improved seeds or fertilizer | 46 | 51.06 | VII |
| 8 | The hanging of skull of dead animal improves the crop raising potential of the lands | 44 | 48.84 | VIII |
| 9 | Seed should not be given to anybody till own sowing is over, otherwise the farmer gets low yield | 42 | 46.62 | IX |
| 10 | Lending or borrowing of money on the starting day of agricultural operations keeps them in the same state that year long | 38 | 42.18 | X |

A sizeable portion i.e., about 51 per cent of the population had this belief. When farmers were asked to enlist reasons associated with this, they failed to do so. For higher yield, besides improved seeds and fertilizers, proper climatic condition such as, rains etc. are also necessary. Many a time, climate, which is governed by nature, is not favourable and crop yield is not as per expectations. Hence, this belief has developed.

### 6. Worshipping of the God for rain

Nearly 80 per cent of the respondents held this belief. But they failed to give any satisfactory reason associated with this belief. However, they told that they were following that because their forefathers followed it. One possible reason behind this might be that it has got assimilated with the culture of the tribals.

### 7. Lending or borrowing of money on the starting day of agricultural operations keeps them in same state all through the year

About 42 per cent of the respondents are of the opinion that lending and borrowing should be avoided on the starting day of agricultural operations. It might be a coincidence for some people that they could not clear their debts or get their money in time when they were involved in this transaction on the starting day of agricultural operations. And it might have become a common belief. However, no scientific reason can be attached to this.

### 8. Sacrificing fowl before sowing and harvesting operations influences the yield

Majority of the respondents (91%) held this opinion and it is being widely practiced now. Offering animal sacrifices had been part of tribal culture in some festivals too. In the course of time, it might have got adapted to agricultural operations also. However, agricultural yields cannot be correlated to that practice and no truth is involved in this belief.

**9. The hanging of the skull of a dead animal improves the crop rising potential of the lands**

Nearly 50 per cent of the respondents indicated a positive feeling towards this opinion. It is a practice since generations. Though tribals could not attach any reason to that, it can be said that elements like calcium and phosphorus from the bony structure of the skull enriches the root to some extent. However, proven scientific logic is not established in this regard.

**10. A cow is sacrificed in the beginning of the agricultural season. Rice grains are soaked in its blood and broadcast over cultivating fields, which was believed to improve the agricultural yield.**

Majority of the respondents (84%) held this belief and it is a prevalent practice there. On the face of it no valid reason can be attached to this practice, but traditionally it has been in practice over generations. Tribals believed that it could bring them good yield, but no one could give any satisfactory reason. Scientifically it can be claimed that no truth is involved in this belief.

It was observed that the majority of the farmers adhered to the existing folk beliefs in this tribe. They were highly resistant to change with regard to their folk beliefs. These folk beliefs seemed to be deep rooted in their culture. Based on the study it is recomended that (i) The spread of civilization and modernization has been checked by the numerous hills and plateaus in the area. Thus, tribals are still following religious practices and worshipping their deities with mixed feelings of fear and supplication. Hence, to overcome the fear of tribals about supernatural beliefs, a flexible programme of science education to explain the nature and man's place in it may be implemented in the area. (ii) The priest was dominating the scene in remote areas due to his knowledge about herbal plants used in the treatment of human beings as well as for animals. The developmental agencies must try to build up a rapport with the 'Priest' and acquire knowledge of various herbal medicines, which may be useful for human as well as livestock. Analyse the utility of herbal plants in the practice of veterinary medicine and (iii) Efforts are needed to educate the tribals including their folk beliefs, in changing their attitude favourable towards dairy farming and in exposing them to various communication sources and institutions operating in the area.

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(Received on 29-9-2001 and revised on 18-2-2002)

The Andhra Agric. J. 49 (3&4) : 334 - 341 , 2002

# A Standardised Test To Measure The Knowledge of Agricultural Officers on Sustainable Agricultural Practices

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## ABSTRACT

The impact of modern agriculture was at the cost of natural resource base and environmental quality preserve the resource base and environmental quality for future lead to the concept of sustainable agriculture. Sustainable agricultre is that form of farming which produces sufficient food to meet the needs of the present generation without eroding the ecological assets and the productivity of the life - supporting system of future generations (Venkataramani, 1991). Knowledge is one of the important components of human behaviour. Extension workers are like the nervous system in the process of rural development. T & V system of extension is based on the philosophy that unless the personnel at different hierarchy are equipped with up-to-date knowledge, they can never be effective change agents. Agricultural Officers (AOs) play key role in departmental programmes. The important position of this crucial change agent in the extension approach makes it necessary to know him in all dimensions. It is well known that a professional extension service will not survive in its reality without technically competent, skilled and highly motivated functionaries. Hence, a greater responsibility is on the shoulders of AOs who are in the field extension specially. With this background the present investigation was carried out to develop and standardise a knowledge test on SAP to measure the knowledge of AOs. Standardization implies uniformity of procedures in administering and scoring the test (Mathur, 1997).

**Key words :** Standardised test, Agricultural Officers Sustainable Agriculture.

### Construction of knowledge test

The standard procedures followed by Sadamate (1978), Rao (1993), Parek and Pandya (1995) and Ameerjan *et al.* (1997) were adopted for developing and standardization of knowledge test for the study. The procedure followed was as follows :

### Collection of items

An item pool of knowledge questions was prepared by consulting scientists, reviewing literature and AOs who were in field extension. A total of 115 items were collected in different areas representing Sustainable Agricultural Practices : a) Soil and water conservation (19), b) Integrated Pest Management (32), c) INM and cropping system (39) d) Water Management (11) and E) Weed Management (14). In selecting the test items the procedure followed was according to Trivedi and Patel (1995).

### Framing of test items

All the 115 items were administered to 20 scientists. The scientists were selected randomly from Agricultural College, Bapatla, Rice Research Unit, Bapatla, Weed Science Unit, Bapatla, Saline water research unit, Bapatla and Regional Agricultural Research Station, Lam. Out of 115 items, 26 were True / False type, 40 were multiple choice type and 49 were fill in the blank type. The frequencies of the judges rating were listed for each statement under most relevant, relevant and least relevant with weightage of 3,2 and 1 respectively. Sixty six items which have their mean score value being equal to or higher than the overall mean score were selected for item analysis.

$$\text{Mean score (individual item)} = \frac{\text{Total score of that item}}{\text{Total no. of judges}}$$

$$\text{Overall mean score} = \frac{\text{Total score of all the statements for all the judges}}{\text{Total no. of statements x total no. of judges}}$$

### Item Analysis

Item analysis of test yields two kinds of information that is an index of item difficulty and index of value. It was carried out by administering the 66 items to 30 AOs. Responses were dichotomised as correct and incorrect with the weightage of 1 and 0 respectively. The total score for each AO was calculated. Then the scores were arranged in descending order. After that they were divided into six groups viz., G1, G2, G3, G4, G5 and G6 with 5 respondents in each group. The middle two groups namely G3 and G4 were eliminated, retaining only the four terminal groups with high (G1 and G2) and low (G5 and G6) scores. Then there were subjected to calculate item difficulty index, item discrimination index and point biserial correlation (Table 1).

### Item difficulty index

The index of item difficulty indicates the extent to which an item is difficult. An item should not be so easy that all the respondents can pass it, nor should not be so difficult that none can pass it. The item with difficulty values ranging from 20 to 80% only were considered for final selection of the knowledge test.

$$\text{DI} = \frac{\text{No. of respondents answering correctly}}{\text{Total no. of respondents}} \text{ x } 100$$

### Item discrimination index (E 1/ 3)

The function of item discrimination index is to find out whether an item really discriminates a well informed respondent from poorly informed respondent. In the present study, the items with E 1/3 values ranging from 0.2 to 0.8 were considered for the final selection in the knowledge test.

$$\text{E } 1/3 = \frac{(S_1 + S_2) - (S_3 + S_6)}{N/3}$$

Point biserial correlation is the test item validation in which the criterion of validity is considered to be internal consistent. i.e. relation between total score and dichotomised response to any given item.

$$\text{rpbis} = \frac{M_p - M_q}{\sigma} \text{ X } \sqrt{pq}$$

Finally 42 items which satisfied the above criteria were selected for knowledge test from 66 items (Table 2).

### Reliability of the Test

Split - half method was used to compute the reliability of the test. The test was administered to 30 respondents and were divided into two halves based on half forms of test and the scores were correlated for the reliability of the half test. The self correction of the whole test was then estimated by the Spearman Brown prophecy formula. The calculated values of reliability co-efficient for whole test found to be highly significant (Table 3), hence, it is concluded that the test was reliable.

Table 1 : Difficulty and discriminating index for knowledge test items and point biserial correlation

| Item No. 1 | Frequencies of correct answer<br>S1 2 | S2 3 | S5 4 | S6 5 | Difficulty index (P) 6 | Discriminating index (E 1/3) 7 | Point biserial correlation (rpbis) 8 |
|---|---|---|---|---|---|---|---|
| 1 | 5 | 3 | 4 | 3 | 73 | 0.1 | NC |
| 2* | 5 | 4 | 4 | 2 | 80 | 0.3 | 0.4251 |
| 3* | 5 | 5 | 4 | 2 | 76 | 0.4 | 0.5067 |
| 4 | 5 | 3 | 5 | 3 | 76 | 0.0 | NC |
| 5* | 5 | 5 | 4 | 2 | 80 | 0.4 | 0.4432 |
| 6* | 5 | 4 | 2 | 3 | 70 | 0.4 | 0.3606 |
| 7* | 5 | 4 | 4 | 2 | 76 | 0.3 | 0.3469 |
| 8* | 5 | 5 | 3 | 3 | 76 | 0.4 | 0.3657 |
| 9* | 5 | 5 | 4 | 3 | 80 | 0.3 | 0.4067 |
| 10 | 5 | 4 | 4 | 2 | 76 | 0.0 | NC |
| 11* | 5 | 4 | 2 | 4 | 73 | 0. | 0.3621 |
| 12 | 5 | 3 | 3 | 3 | 80 | 0.2 | 0.1411 NS |
| 13* | 5 | 5 | 4 | 2 | 76 | 0.4 | 0.4036 |
| 14* | 5 | 5 | 4 | 4 | 80 | 0.6 | 0.3651 |
| 15* | 5 | 4 | 2 | 2 | 73 | 0.5 | 0.3787 |
| 16 | 5 | 5 | 4 | 4 | 80 | 0.6 | 0.2968 NS |
| 17* | 5 | 4 | 3 | 3 | 76 | 0.3 | 0.3543 |
| 18* | 5 | 5 | 3 | 3 | 80 | 0.4 | 0.4433 |
| 19* | 5 | 5 | 3 | 2 | 73 | 0.3 | 0.4037 |
| 20 | 5 | 5 | 3 | 4 | 80 | 0.3 | 0.2693 NS |
| 21 | 5 | 4 | 4 | 4 | 73 | 0.1 | NC |
| 22* | 5 | 5 | 3 | 3 | 73 | 0.4 | 0.4619 |
| 23* | 5 | 4 | 4 | 2 | 76 | 0.3 | 0.4179 |
| 24* | 5 | 5 | 3 | 3 | 76 | 0.4 | 0.5070 |
| 25 | 5 | 5 | 3 | 4 | 76 | 0.3 | 0.2008 NS |
| 26 | 5 | 4 | 3 | 4 | 76 | 0.2 | 0.2884 NS |
| 27* | 5 | 4 | 3 | 2 | 73 | 0.4 | 0.3871 |
| 28* | 5 | 5 | 3 | 2 | 70 | 0.5 | 0.4565 |
| 29 | 5 | 4 | 5 | 4 | 80 | 0.0 | NC |
| 30* | 5 | 5 | 2 | 4 | 80 | 0.4 | 0.3609 |
| 31* | 5 | 5 | 3 | 2 | 73 | 0.5 | 0.4369 |
| 32* | 5 | 4 | 3 | 2 | 76 | 0.4 | 0.4546 |
| 33 | 2 | 1 | 0 | 2 | 16 | 0.1 | NC |
| 34* | 5 | 5 | 2 | 0 | 73 | 0.2 | 0.7194 |
| 35* |  | 3 | 4 | 2 | 73 | 0.2 | 0.3704 |
| 36* | 5 | 5 | 3 | 3 | 73 | 0.4 | 0.4037 |
| 37 | 5 | 4 | 4 | 3 | 86 | 0.2 | NC |

Contd.............

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 38 | 2 | 2 | 1 | 0 | 16 | 0.3 | NC |
| 39 | 0 | 2 | 0 | 1 | 16 | 0.1 | NC |
| 40* | 5 | 5 | 2 | 3 | 80 | 0.5 | 0.4983 |
| 41* | 5 | 4 | 5 | 3 | 80 | 0.2 | 0.3672 |
| 42 | 1 | 2 | 1 | 1 | 16 | 0.1 | NC |
| 43 | 5 | 4 | 3 | 3 | 80 | 0.2 | 0.1869 NS |
| 44* | 5 | 2 | 3 | 3 | 80 | 0.3 | 0.3645 |
| 45 | 5 | 3 | 4 | 3 | 73 | 0.1 | NC |
| 46 | 5 | 4 | 4 | 3 | 80 | 0.2 | 0.2693 NS |
| 47 | 4 | 5 | 5 | 5 | 96 | 0.1 | NC |
| 48 | 5 | 5 | 5 | 5 | 93 | 0.0 | NC |
| 49* | 5 | 5 | 2 | 2 | 80 | 0.6 | 0.5573 |
| 50* | 5 | 5 | 3 | 3 | 76 | 0.4 | 0.4196 |
| 51* | 5 | 4 | 4 | 2 | 76 | 0.2 | 0.4021 |
| 52* | 5 | 5 | 3 | 1 | 80 | 0.6 | 0.6265 |
| 53* | 5 | 4 | 4 | 2 | 76 | 0.3 | 0.3884 |
| 54* | 5 | 4 | 4 | 3 | 80 | 0.2 | 0.3642 |
| 55* | 2 | 5 | 1 | 3 | 80 | 0,6 | 0.4432 |
| 56 | 1 | 2 | 1 | 1 | 16 | 0.1 | NC |
| 57 | 2 | 1 | 1 | 1 | 16 | 0.1 | NC |
| 58* | 5 | 5 | 4 | 3 | 80 | 0.3 | 0.3884 |
| 59* | 5 | 4 | 4 | 1 | 80 | 0.4 | 0.5166 |
| 60* | 5 | 5 | 3 | 1 | 80 | 0.4 | 0.5807 |
| 61* | 5 | 5 | 3 | 2 | 80 | 0.6 | 0.4483 |
| 62 | 2 | 1 | 1 | 1 | 16 | 0.1 | NC |
| 63 | 2 | 1 | 1 | 1 | 16 | 0.1 | NC |
| 64* | 5 | 5 | 4 | 0 | 80 | 0.6 | 0.6631 |
| 65* | 5 | 5 | 4 | 1 | 80 | 0.5 | 0.5349 |
| 66* | 5 | 5 | 4 | 1 | 80 | 0.5 | 0.5074 |

NS - Non significant

NC - Point biserial correlation coefficient (rpbis) is not calculated for items with difficulty index (p) more than 80 and less than 20 and items with discrimination index (E 1/ 3) more than 0.8 and less than 0.2..

* - Items selected for the final knowledge test.

Table 2 : Items selected for the final knowledge test

**I. Soil & Water Conservation**

1. Formation of Dead furrows across the slope of field improves the soil and water conservation True / False

2. Cenchurus ciliaris + Stylosanthus hamata are best suited to stabilize bunds. True / False

3. In general, the agronomic measures of soil conservation give better results if the field slope is around __________ %

4. Please name some important cover crops that could be recommended for checking soil erosion ______________

5. The grass that is commonly grown as live - barrier across the slope to conserve soil and water is ______________

6. Growing of trees across the wind direction as a measure to ckeck wind erosion is termed as ______________

7. Soil conservation means

a) Using and managing land based on its capability

b) Application of practices that do not damage the soil

c) A & B d) None of the above ( )

8. Meaning of watershed is

a) It is an area of land and water bounded by a drainage divide within which the runoff collects and flows through a single outlets

b) It is a area above a given point on a stream that contributes water to the flow at that point

c) A & B d) None ( )

**II. Integrated Nutrient Management and Cropping Systems**

9. Legumes are well suited to green manuring because of their low Carbon to Nitrogen ratio True / False

10. Usually, the content of Ca and P are higher in vermicompost than in Farm Yard Manure. True / False

11. The biofertilizer that is recommended for pulse crop is ______________

12. In general, the quantity of biofertilizer (*Rhizobium* Culture) recommended for one hectare of pulses is ______________

13. Please mention the way in which inoculation of pulse seed is done with biofertilizer ______________

14. Please give the usual dose of Blue Green Algae application in rice field ______________

15. Please mention the time of application of Blue Green Algae ______________

16. Name few plants / trees used for green leaf manuring ______________

17. Desirable cost benefit ratio of any cropping system is

a) < 1.0 b) 1.0

c) > 1.0 d) None ( )

18. Main objective of mixed farming is

a) Subsistance b) Profitability

c) A & B d) None of the above ( )

**III. Water Management**

19. Best quality irrigation water has an Electrical Conductivity of less than ____________ milli mhos / cm.

20. The stage of crop at which irrigation is scheduled, if only one / two irrigations available ____________

21. Furnish, soil moisture sensitive stages of major crops grown in your region ____________

22. Efficient method of irrigation for orchards ____________

23. The Broad - bed and furrow method is the best method of irrigation for ____________ soils.

24. The water harvesting method (s) in semi - arid regions

a) Farm ponds b) Inter row water harvesting

c) Broad - bed and furrows d) All ( )

**IV. Integrated pest managment**

25. Thuricides generally used against the moth pests. True / False

26. Mode of action of thuricide is paralyzing the gut and mouth parts of insects. True / False

27. The load of pest population at which pesticide spraying is recommended ____________

28. The most populat bactericide is ____________

29. Please name one popular egg parasite ____________

30. Please mention two places in Andhra Pradesh from which parasites used for pest control could be obtained.

1. 2.

31. IPM means

a) Completely earadication the pests.

b) Keeping the pest population below E T L level.

c) Leaving the pest without taking any measures to control

d) All the above ( )

32. The following practice is useful to break pest multiplication

a) Crop rotation b) Multiple cropping

c) A & B d) None ( )

33. I P M includes

a) Chemical control b) Cultural control

c) Biological control d) None ( )

34. Pheramones mode of action is

a) Killing the pests b) Disrupting the mating

c) A & B d) None ( )

35. Usually the following number of pheramone traps are required per one hectare to control insect population

a) 5 - 10 b) 25 - 30

c) Celphos tablets d) All the above ( )

36. The chemical used to control rats

a) Zine phosphide b) Bromodiolone (Robon cakes)

c) Celphos tablets d) All the above ( )

V. Integrated Weed Management

37. Smothening crops such as cowpea and pillipesara can be used as inter crops to check weed growth in wide spaced crops. True / False

38. Prickly pear (*Opuntia dillinii*) was successfully controled by *Doctylopium tomentosus* (Scale insect). True / False

39. Integrated weed management, the following practice of weed control will be given greater importance.

a) Biological b) Cultural

c) Physical d) Chemical ( )

40. Pre - emergence application of herbicide means

a) Pre emergence to weeds

b) Pre emergence to crop

c) Pre emergence to crop and weed

d) None of the above ( )

41. The best indicator weed for soil salinity

a) *Sida acuta* b) *Plygonum spp.*

c) *Crissa critica* d) All the above ( )

42. The following is a translocated herbicide

a) Paraquat b) Glyphosate

c) 2,4-D d) All the above ( )

## Validity

The content of the knowledge test was derived from a long list of the test items. Those test items represented the total universe of sustainable agricultural practices. It was thus assumed that the total scores obtained by administering the knowledge test of the study measures what was intended to measure. The validity of the test items was also tested by the method of point biserial correlation as adopted by Parekh and Pandey (1995) and Trivedi and Patel (1995). The items having significant point biserial correlation coefficient at 1 per cent and 5 per cent level indicated the validity of the items in relation to the knowledge test designed to measure the knowledge on sustainable agricultural practices.

The test was subjected to predictive validity also. Kulhari (1980) revealed AEWs with higher knowledge evince better performance in their job, hence, job performance was considered as criterion for the study. Accordingly, job performance score was derived for each agricultural officer. Following the group differentiation method (Brown, 1983), as used by Ameerjan *et al.* (1997), it was found that those AOs with high job performance scores had significantly higher knowledge scores when compared to those with low knowledge score.

## Administration of knowledge test

An individual would get one score for correct response and zero for wrong response. Thus the range of score would vary between 0 and 42.

The scores thus obtained would be converted into Z scores and based on Mean and SD, the respondents may be categorised as follows :

| S.No. | Category | |
|---|---|---|
| 1. | High knowledge | Mean + SD |
| 2. | Medium knowledge | Mean + SD |
| 3. | Low knowledge | Mean - SD |

It can be concluded that the test was developed and standardised by following the standard procedures. The reliability and validity of the test was also found to be highly significant. Hence, it can be used to find out knowledge of Agricultural Officers or any extension personal who are working at the farmers level, considering the local conditions i.e., practices followed.

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(Received on 20 -7 -2001 and revised on 11- 12 -2002)

The Andhra Agric. J. 49 (3&4) : 342 - 345, 2002

# Resource Use Efficiency of Whole Farm Approach - Tribal Agriculture in Khammam District of Andhra Pradesh

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## ABSTRACT

The studiy indicated that the resource use efficiency in tribal agriculture with respect to coefficient of multiple determination ($R^2$) for all farms varied from 0.67 to 0.86 and found to be were statistically significant. The M.V.P. to opportunity cost ratios in all categories were less than one for all the variables included in the analysis. Bullock labour and seed were used excessively by large farmers.

**Key words** : Efficiency, Approach, Tribal, Agriculture.

Tribal agriculture is associated with raising of more number of crops as even if one crop fails others compensates the losses. To improve tribals the ITDA was established to bring about over all development of the tribals in the area. The ITDA has the over all responsibility of bringing about the development of the tribals of the areas by utilising its own funds. It was observed that there was a marginal increase in the total cultivated area under post implementation of ITDA programmes.

The tribal farmers brought some changes in package of practices in the cultivation of different crops with the implementation of different programmes through ITDA. The present study examines the resource use efficiency in tribal agriculture after the implementation of ITDA programme.

## MATERIAL AND METHODS

Khammam district was purposively selected for the present study because it ranked first in the state in tribal population. At the second stage five mandals were selected randomly from the list of mandals implementing ITDA developmental programmes. At the third stage villages from each mandal were selected based on the highest number of beneficiaries under these selected vilages. From each village beneficiaries were selected adopting random sampling technique with probability proportion to diferent size of holdings. Thus one district 5 mandals, 17 villages and 296 beneficiaries constituted the sample for the study.

Cobb-Douglas production model was used to estimate resource productivity and resource use efficiency and returns to scale. The form of the production function is as follows.

$$Y = ax_1^{b1}\, x_2^{b2}\, x_3^{b3} \ldots\ldots\, x_k^{bk}$$

Where Y= out put; $x_1$ to $x_k$ = inputs

$b_1$ ....... $b_k$ are the regression parameters.

A: constant

The function is linear in logarithams and written in the following log form as

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Table 1: Production elasticities of different inputs factors

| Particulars | Small | Medium | Large | All farms |
|---|---|---|---|---|
| No. of samples | 94 | 117 | 85 | 296 |
| Constant (a) | 1.5613 | 2.0454 | 1.6442 | 1.3323 |
| land $X_1$ | -0.0153<br>(0.0421) | 0.2924**<br>(0.0764) | 0.2369**<br>(0.0653) | 0.1680**<br>(0.0408) |
| Human labour $X_2$ | 0.136**<br>(0.0528) | 0.1820**<br>(0.0427) | 0.7104**<br>(0.0909) | 0.2318**<br>(0.0339) |
| Bullock labour $X_3$ | 0.2183*<br>(0.1298) | 0.2096**<br>(0.0808) | -0.1798<br>(0.1113) | 0.3129**<br>(0.0629) |
| Seed value $X_4$ | 0.2540**<br>(0.0546) | 0.1408**<br>(0.0450) | -0.0911<br>(0.0552) | 0.1172**<br>(0.0331) |
| Manures and Fertilizers $X_5$ | 0.1692*<br>(0.0814) | 0.0539<br>(0.0478) | 0.2040**<br>(0.0510) | 0.1794**<br>(0.0389) |
| Irrigation $X_6$ | 0.0621**<br>(0.0230) | 0.0209<br>(0.0128) | 0.6000**<br>(0.0233) | 0.0439**<br>(0.0117) |
| Σbi | 0.8246<br>(0.3213) | 0.8997<br>(0.3342) | 0.9406<br>(0.4211) | 1.0534<br>(0.7101) |
| $R^2$ | 0.67 | 0.79 | 0.87 | 0.86 |

* 0.05 per cent level of significance and ** at 0.01 per cent level of significance

Figures in parentheses indicate standard errors of the coefficients

Σbi = Sum of elasticitics / returns to scale

$$\text{Log } Y = \log a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + \ldots\ldots\ldots\ldots\ldots + b_k \log x_k$$

Y = gross income

Where, $X_1$ = Land in ha, $X_2$ = Human labour (Rs.); $X_3$ = Bullock labour (Rs.); $X_4$ = Seed value (Rs.), $X_5$ = Manures and fertilizers (Rs.); $X_6$ = Irrigation charges (Rs.).

In Cobb-Douglas production function, marginal value product (MVP) of X, for the ith input factor is given by the following formula.

$$\text{MVP of } X_1 = \frac{\bar{Y}}{\bar{X}} \text{ x bi}$$

Where, $\bar{Y}$ = Geometric mean of output Y

$\bar{X}$ = Geometric mean of input $X_i$

$b_i$ = Regression coefficient of $X_i$

## RESULTS AND DISCUSSION

The sizewise results of the production functions for all the crops put together (whole farm approach) are presented in Table 1:

### Resource returns

Small Farms

The coefficient of multiple determination ($R^2$) for small farm was 0.67, which was found statistically significant. This indicated that 67 per cent of the variation in the gross income was explained by the independent variables included in the function. The coefficients ($bi_s$) of the independent variables of the Cobb-Douglas function represent the elasticities of the respective input variables. It was found that the coefficients were statistically significant

Table 2 : Resource use efficiency for whole farm approach

| M.V.P. | Small | Medium | Large | All farms |
|---|---|---|---|---|
| land $X_1$ | -0.1456 | 2.0077 | 1.2568 | 1.1669 |
| Human labour $X_2$ | 0.1687 | 0.2206 | 0.8687 | 0.2837 |
| Bullock labour $X_3$ | 0.3121 | 0.2974 | -0.2530 | 0.4439 |
| Seed value $X_4$ | 0.3771 | 0.1963 | -0.1295 | 0.1676 |
| Manures and Fertilizers $X_5$ | 0.2414 | 0.0758 | 0.2808 | 0.2518 |
| Irrigation $X_6$ | 0.1337 | 0.0452 | 0.1128 | 0.0906 |
| OC | | | | |
| land $X_1$ | – | – | – | – |
| Human labour $X_2$ | 1.000 | 1.000 | 1.000 | 1.000 |
| Bullock labour $X_3$ | 1.000 | 1.000 | 1.000 | 1.000 |
| Seed value $X_4$ | 1.000 | 1.000 | 1.000 | 1.000 |
| Manures and Fertilizers $X_5$ | 1.000 | 1.000 | 1.000 | 1.000 |
| Irrigation $X_6$ | 1.000 | 1.000 | 1.000 | 1.000 |
| MVP/OC Ratio | | | | |
| land $X_1$ | – | – | – | – |
| Human labour $X_2$ | 0.1687 | 0.2206 | 0.8687 | 0.2837 |
| Bullock labour $X_3$ | 0.3121 | 0.2974 | -0.2530 | 0.4439 |
| Seed value $X_4$ | 0.3771 | 0.1963 | -0.1295 | 0.1676 |
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| Irrigation $X_6$ | 0.1337 | 0.0452 | 0.1128 | 0.0906 |

MVP = marginal value products OC = Opportunity cost

corresponding to human labour, bullock labour, seed, manures and fertilizers, and irrigation. The elasticities of production corresponding to these variables were 0.14, 0.22, 0.25, 0.17 and 0.06 significant. One per cent increase in these variables keeping others constant, would increase gross income by 0.14, 0.22, 0.25, 0.17 and 0.06 per cent respectively.

### Medium farms

The coefficient of multiple determination ($R^2$) for medium farms was 0.79 and was found statistically significant. This indicated that 79 per cent of the variation in the gross income was explained by the variables included in the function. The production elasticities of land, human labour, bullock labour and seed value were 0.29, 0.18, 0.21 and 0.14 which were positive and significant. Keeping other factors constant, one per cent increase in land, human labour, bullock labour and seed costs would increase gross income by 0.29, 0.18, 0.21 and 0.14 per cent respectively.

### Large farms

The coefficient of multiple determination ($R^2$) for large farms was 0.87 and bound statistically significant. This indicated that 87 per cent of the variation in the gross income was explained by the variables included in the function. On land, human labour, manures and fertilizers and irrigation would increase the gross income by 0.24, 0.71, 0.20 and 0.60 per cent.

All farms

The coefficient of multiple determination ($R^2$) for all farms was 0.86 and was found to be statistically significant. This indicated that 86 per cent of the variation in the gross income was explained by the variables included in the function. The production elasticities of land, human labour, bullock labour, seed, manures and fertilizers and irrigation were 0.17, 0.23, 0.31, 0.12, 0.18 and 0.04 which were positive and statistically significant. These variables contributed positively and significantly to the gross income.

Returns to scale

The sum of partial regression coefficients in Cobb-Douglas function indicates returns to scale. The sum of regression coefficients has been tested against unity. It was found that decreasing returns to scale is operating the case of small, medium and large size groups, where as in the case of all farms constant returns to scale was found to be operating.

Resource use of efficiency

The efficiency of the resources used in the production of crops is estimated by comparing the marginal value product of inputs with the opportunity costs. The expenditure. irrespect of MVP per rupee incurred on land, human labour, bullock labour, seed, manures and fertilizers and irrigation and the MVP of land are computed and compared with the opportunity costs. The opportunity costs for all the variables are considered to be one rupee except that of land, where the actual acquisition cost is taken since it is expressed in physical units. The particulars of MVPs opportunity cost and their ratios of whole farm approach are presented in Table 2. It is evident from the table that the ratios of MVP to opportunity cost ratios were less than one for all the categories of farms and hence the expenditure on these inputs need to be decreased. In respect of large farms the ratios of MVP to opportunity cost for bullock labour and seed were negative indicating their excessive use.

Therefore the reorganization of these resources is essential to raise the productivity level of tribal farms.

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(Received on 13-9-2000 and revised on 25-11-2001.)

The Andhra Agric. J. 49 (3&4) : 346 - 350, 2002

# A Study on Costs and Returns in Cultivation of Jasmine, Rose and Crossandra in East Godavari District of Andhra Pradesh

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## ABSTRACT

The specific objective of the study is to estimate the costs and returns in cultivation of jasmine, rose and crossandra crops. For collecting the information regarding costs and returns per hectare, a sample of 30 farmers each was selected for jasmine, rose and crossandra. The data collected was subjected to tabular analysis. Total cost of cultivation per hectare was highest in case of rose i.e., Rs. 1,15,675.08 followed by jasmine with Rs. 1,05,816.49 and in crossandra it is Rs. 72,834.14. Net income realized per hectare was highest in case of jasmine Rs. 42, 683.51 followed by 40,984.92 in rose and Rs. 31,357.51 in crossandra.

**Key Words :** Cost and Returns, Cultivation Jasmine, Rose, Crossandra, East Godavri, Perennial costs.

Total area under flower crops in India is about 35,000 hectares. Crossandra, jasmine and rose are the most important flower crops of India. But most of jasmine and crossandra were being grown in states of Tamil Nadu, Andhra Pradesh and Karnataka. The heavy of concentration of flower production in these states is due to prevalence of markets for traditional flowers. Total area under flower crops in India is about 35,000 hectares. East Godavari district was purposively selected for the study as it ranks first among flower producing districts in Costal Andhra Pradesh, with an area of 854 hectares, during 1994-95. Production costs plays an important role in the process of decision making by farmer. Therefore studies on cost of production are useful for the correct understanding of the components of the cost of production and their influence on the returns. The specific objective of the study is to estimate the cost of returns in cultivation of jasmine, rose and crossandra.

## METHODOLOGY

The study was conducted in East Godavari district of Andhra Pradesh. Two mandals viz., Kadium and Alamuru were selected purposively since these two mandals have maximum area under flower crops. From each mandal, two villages were selected with the highest area under flower cultivation. A sample of 30 farmers each was selected for rose, jasmine and crossandra, thus making a total of 90 farmers. The samples were selected as per the probability proportion to the area under each selected flower crop in the selected villages for the study. The data pertaining to the selected flower farms obtained through survey method for the agricultural year 1995-96 with the help of pre - tested and well structured questionnaires. The data collected were subjected to tabular analysis. This was done by working out simple averages of various costs and various measures of farm income.

Table 1 : Establishment cost of jasmine and rose garden / hectare

| | Jasmine (Rs ha$^{-1}$) | Rose (Rs ha$^{-1}$) |
|---|---|---|
| **A. Total labour cost** | | |
| Land preparation | 625.00(1.65) | 625.00(0.81) |
| Digging pits and planting | 7500.00(19.90) | 3375.00(4.39) |
| Manures and fertilizers application | 1250.00(3.31) | 1250.00 (1.62) |
| Weeding and intercultivation | 3000.00(7.98) | 3125.00(4.07) |
| Irrigation | 1562.50(4.16) | 6000.00(7.81) |
| Application of Plant Protection chemicals | 937.50(2.48) | 1000.00(1.30) |
| | **14,875.00(39.49)** | **15,375.00(20.00)** |
| **B. Total material cost** | | |
| Planting material | 5000.00(13.26) | 33,750.00(43.97) |
| Farm yard manure | 3250.00(8.62) | 3250.00(4.25) |
| Fertilizers | 4125.00(10.94) | 4250.00(5.53) |
| Plant protection chemicals | 7750.00(20.56) | 8125.00(10.58) |
| Electrical charges | 2687.50(7.13) | 12000.00(15.66) |
| | **22812.50 (60.51)** | **61,375.00(80.00)** |
| Total establishment cost (A + B) | **37,687.50(100.00)** | **76,750.00(100.00)** |

Note : Figures in parentheses indicate percentage to total

As jasmine and rose are perennial crops establishment cost of the garden was calculated. The establishment cost include all the expenditure incurred during the pre-economic flowering period. Items like preparation of land, cost of ploughing, digging pits, cost of planting material, cost of manures and fertilizers, cost of plant protection chemicals, cost of irrigation, cost of intercultural practices were considered as establishment cost.

### Maintenance cost

All recurring costs required for maintaining the plants during active flowering period such as expenditure on cultural practices, manures and fertilizers, plant protection chemicals, irrigation, pruning, weeding etc., were considered as maintenance cost. Besides, these interest on working capital was also included in maintenance cost.

### Annuity value of establishment cost

Jasmine and rose were being perennial crops. Annuity value of total establishment cost was calculated for economic flowering period which was fixed as 10 years for jasmine and 5 years for rose respectively.

$$\text{Annuity value of establishment cost} = \frac{[C(1+r)^N][1-(1+r)]}{1-(1+r)^N}$$

Where C= Capital cost

r = Rate of interest (Discount rate)

N = Number of years

In the present study for easy understanding total establishment cost was divided into two sub heads viz., total labour cost and total material cost.

Table 2 : Cost of cultivation of jasmine, rose and crossandra per hectare

| S.No. | Item | Cost in rupees Jasmine | Rose | Crossandra |
|---|---|---|---|---|
| 1. | Seed material | - | - | 3,110.40<br>(4.27) |
| 2. | Human labour | 44,132.52<br>(41.70) | 25.599.47<br>(22.13) | 27.139.32<br>(37.27) |
| 3. | Machine labour | 3,838.50<br>(3.62) | 16,141.65<br>(13.95) | 2,744.15<br>(3.78) |
| 4. | Manures and fertilizers | 8,361.95<br>(7.92) | 8,167.90<br>(7.99) | 5,820.82<br>(7.06) |
| 5. | Plant protection chemicals | 8.590.60<br>(8.11) | 10.021.87<br>(8.66) | 2,610.40<br>(3.58) |
| 6. | Interest on working capital | 4,057.69<br>(3.83) | 3,745.68<br>(3.25) | 2,589.06<br>(3.55) |
| **A. Total operational cost** | | **68,981.29**<br>**(65.18)** | **63,676.57**<br>**(55.05)** | **44,014.15**<br>**(60.44)** |
| 1. | Rental value of leased land | - | - | 1,666.66<br>(2.28) |
| 2. | Depreciation charges | 1,050.00<br>(0.99) | 965.00<br>(0.83) | 805.00<br>(1.10) |
| 3. | Rental value of owned land | 25,000.00<br>(23.65) | 25,000.00<br>(21.61) | 23,333.33<br>(32.03) |
| 4. | Anniity value of establishment cost | 7,512.70<br>(7.10) | 22,911.01<br>(19.80) | - |
| 5. | Land revenue | 210.00<br>(0.19) | 210.00<br>(0.18) | 210.00<br>(0.28) |
| 6. | Interest on fixed capital | 3,062.50<br>(2.89) | 2,912.50<br>(2.51) | 2,805.00<br>(3.87) |
| | **B. Total fixed costs** | **36,835.20**<br>**(39.56)** | **51,998.51**<br>**(34.82)** | **28,819.99**<br>**(44.95)** |
| | **Total cost of cultivation per hectare = A + B** | **1,05,816.49**<br>**(100.00)** | **1,15,675.08**<br>**(100.00)** | **72,834.14**<br>**(100.00)** |

Note : Figures in the parenthesis indicate percentage to total

## RESULTS AND DISCUSSION

The results are presented and discussed below crop wise

### Jasmine

It is evident (Table 1) that contribution of total labour cost to the total establishment cost was Rs. 14,875.00 and that of material cost was found to be Rs. 22,812.50 per hectare. In the total labour cost, digging pits and planting accounts to Rs. 7,500.00 followed by weeding and intercultivation Rs. 3,000.00, for application of irrigation Rs. 1562.50, manures and fetilizers Rs. 1,250.00, plant protection chemicals Rs. 937.50, manures and fertilizers Rs. 1,250.00, plant protection chemicals Rs. 937.50 and land preparation Rs. 625.00 per hectare.

## Gross and net returns

Table 3 : Gross and net returns obtained from crossandra, jasmine and rose per hectare

| Particulars | Jasmine | Rose | Crossandra |
|---|---|---|---|
| Cost of cultivation (Rs. ha$^{-1}$) | 1,05,816.49 | 1,15,675.08 | 72,834.14 |
| Total physical returns | 8,250.00kg | 1,56,600 flowers | 3,473.00 kg |
| Gross returns (Rs. ha$^{-1}$) | 1,48,500.00 | 1,56,600.00 | 1,04,191.65 |
| Net returns (Rs. ha$^{-1}$) | 42,683.51 | 40,924.92 | 31,357.51 |
| Net benefit cost ratio | 0.40 | 0.35 | 0.30 |

Plant protection chemicals worth of Rs. 7,750.00 followed by planting material of Rs. 5,000.00, fertilizers of Rs. 4,125.00, farm yard manure of Rs. 3,250 and electrical charges worth of 2,687.50 were used making the total material cost incurred per hectare of establishing jasmine garden to Rs. 22,812.50.

### Rose

The toal labour cost accounts to Rs. 15, 375 (Table 1) and that of material at cost amounts to Rs. 61,375.00 for the establishment of rose garden per hectare.

To the total labour cost of Rs. 15,375 cost of irrigation accounts to Rs. 6,000 followed by digging pits and planting of Rs. 3,375.00, weeding and intercultivation of Rs. 3,125.00, manures and fertilizers application of Rs. 1,250.00 plant protection chemicals application of Rs. 1,000/- and land preparation of Rs. 625.00.

Panting material worth of Rs. 33,750 followed by electrical charges of Rs. 12,000, plant protection chemicals of Rs. 8,125, fertilizers of Rs. 4,250 and farm yard manure of Rs. 3,250 were used making the total material cost incurred per hectare of establishing rose garden to Rs. 61, 375/-.

## Cost of cultivation of crossandra, jasmine and rose per hectare

For convenience sake the toal cost of cultivation per hectare was divided in to total operational cost and total fixed cost.

The cost of seed material per hectare of crossandra was found to be Rs. 3,110.40. The cost of seed material incase rose and jasmine was not indicated as it was included in establishment cost (Table 2).

The cost of human labour per hectare was highest i.e. Rs. 44,132.50, in case of jasmine followed by crossandra Rs. 27,139.52 and rose Rs. 25,599.42. Human labour was utilized mainly for operations like harvesting, intercultural operations, applications of manures and fertilizers and plant protection chemicals and for irrigation application etc.

The cost incurred towards machine labour was Rs. 16,141.65 in case of rose followed by Rs. 3,838.50 and Rs. 2,744.15 in case of jasmine and crossandra per hectare, respectively.

Manures and fertilizers worth of Rs. 8,361.95 Rs. 8167.90 and Rs. 5,820.82 were utilized in case of jasmine, rose and crossandra per hectare, respectively. The cost of plant protection chemicals was found to be

Rs. 10,021.87, Rs. 8590.60 and Rs. 2,610.40 in case of rose and crossandra per hectare. The sharp decline in the cost of plant protection chemicals used in case of crossandra when compared to that of rose and jasmine was that because later two were perennial crops their canopy was large, so naturally higher amount of plant protection chemicals wer needed.

The total operational cost per hectare was found to be the highest i.e. Rs. 68,981.29 in case of jasmine followed by Rs. 63,676.57 and Rs. 44,014.15 in case of rose and crossandra, respectively. Interest in working capital was also of the same order because it was directly proportional to the operational cost.

The total fixed cost was Rs. 51,998.51 with respect to rose followed by 36,835.20 and Rs. 28,819.99 in case of jasmine and crossandra. Because of the inclusion of annuity value of establishment cost as an entity in case of perennial crops, rose and jasmine, the total fixed cost was found to be higher than crossandra, which is an annual crop. Rental value of owned land was taken as Rs. 25,000 per hectare based on prevailing lease rates for the commercial crops in the stuy area.

The total cost of cultivation per hectare was found to be highest i.e. Rs. 1,15,675.08 with respect to rose followed by Rs. 1,05,816.49 and Rs. 72,834.14 in case of jasmine and crossandra.

The total cost cultivation per hectare was Rs. 1,15,675.08, Rs. 1,05,816.49 and Rs. 72,834.14 in case of rose, jasmine and crossandra, respectiely (Table 3). Gross returns were highest in case of rose Rs. 1,56,600.00 followed by Rs. 1,48,500.00 and 1,04,191.65 with respect to jasmine and crossandra. But per hectare net returns were higher in case of jasmine i.e. Rs. 42,683.51 than rose with Rs. 40,924.92. The difference between gross returns and total cost of cultivation was more in case of jasmine hence net returns were high when compared with rose. Benefit cost ratio was found to be 0.40, 0.35 and 0.30 in jasmine, rose and crossandra, respectively.

It can be concluded that the cost of cultivation per hectare was Rs. 1,15,675.08, Rs. 1,05,816.49 and 72,834.14 and rose, jasmine and crossandra, respectively. Net returns worth of Rs. 42,683.51, Rs. 40, 924.92 and Rs. 31,357.51 were realized with respect to jasmine, rose and crossandra. Benefit cost ratio of 0.40, the highest was conceived in case of jasmine. Therefore, the cultivation of jasmine was found to be most profitable of three flower crops selected for the study under the prevailing local conditions.

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(Received on 5-12-2001 and revised on 7-1-2002)

The Andhra Agric. J. 49 (3&4) : 351 - 353, 2002

## Research Note

# Fish Production in Nagaland - A Regression Approach

**Key Words :** Fish, Nagaland, Regression Approach

Nagaland is a state of hilly mountains and evergreen forests, which is surrounded by Myanmar in East, State of Assam in the West and North, and the state of Manipur in the South. It lies between 25° 6 and 27° 4 North latitudes and 93 ° 23 - 95° 15 East longitudes. It has a total areas of 16,580 sq. km. with the total population of 12,09,547 (1991 census). The whole state enjoys the popular monsoon type of climate with an annual average rainfall of 250 cm. and 85% of relative humidity. Fish growing is not a new practice in Nagaland. Paddy cum fish culture is the most common practice. Almost 90% of the fishes consumed by the people of Nagaland are imported from the neighbouring states like - Assam, West Bengal, Bihar and Andhra Pradesh etc.. In general an average individual growth rate of 0.8 to 1 kg / 10-12 month and a yield of 10 tonnes per ha. per year having from composite fish culture system. The fish production in Nagaland is not at all sufficient for supplying in all over the State. As the demand for fish is increasing day by day in Nagaland and India as a whole, there is a lot of scope for the fish farming in Nagaland to fulfill its requirement. Therefore, to increase the production of fish in Nagaland, it becomes important to identify the control factors which are governing the production of fish. Keeping this in view, an attempt has been made to study the fish production in Nagaland.

To conduct this study, time series data were collected for years, number of fishery ponds, value of fingerlings supplied, value of fish products and number of beneficiary from the Directorate of Economics and Statistics, Govt. of Nagaland, Kohima at state level for the period 1984 - 85 to 1995 - 96. The choice of model to be adopted for the study depends upon the type of the data and problem in hand. Multicollinearity in the data was evaluated which was found to be insignificant. Therefore, for a good measure a multiple linear regression approach was adopted.

It is of the form :

$$Y = A + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e \qquad (1)$$

Where,

$Y$ = Fish production in Lakhs. Rs.

$X_1$ = No. of fishery ponds

$X_2$ = Fingerlings supplied in Lakhs. Rs.

$X_3$ = No of beneficiary

$e$ = Random distrubance term

$A$ = Intercept

$\beta_1$,$\beta_2$ and $\beta_3$ are the partial regression coefficients of the respective explanatory variables. The function was fitted by the method of ordinary least squares applied to the data.

Table : Estimated multiple regression for fish product for Nagaland (1984 - 85 to 1995 - 96).

| Variables | Mean | S.D. |
|---|---|---|
| $X_1$ | 1105.5833 | 345.0076 |
| $X_2$ | 28.1308 | 27.5544 |
| $X_3$ | 1748.7500 | 1217.5452 |
| Y | 352.4875 | 234.9144 |

| Variable | Reg. coeff. | S.E. | T(DF = 8) |
|---|---|---|---|
| $X_1$ | -0.1015* | 0.0363 | -2.796 |
| $X_2$ | 7.2013** | 1.1756 | 6.126 |
| $X_3$ | $-0.0059^{NS}$ | 0.0231 | -0.256 |
| Constant | 272.4248 | 0.0154 | |

Standard error of esimates = 79.0670

Coefficient of Multiple determination ($R^2$) = 0.9176***

Multiple Correlation (R) = 0.9579

ANOVA for Regression

| Sources of Variation | SS | DF | MSS | F- Ratio |
|---|---|---|---|---|
| Regression | 557019.6909 | 3 | 185673.2303 | 29.700 |
| Residual | 50012.7498 | 8 | 6251.5937 | |
| Total | 607032.4406 | 11 | | |

* Significant at 0.5 level

** Significant at 0.01 level

*** Significant 0.05 level

NS Non Significant

$R^2$ Coefficient of multiple determination

It is estimated the regression equation (1) and compiled in the table. The results are exact.

In this study the value of multiple correlation (R) and Coefficients of multiple determination ($R^2$) was found to be 0.958 and 0.918 respectively. This indicates that 92% of the total variation in the fish product of 12 years (1984-85 to 1995-96) can be accounted for by a linear function involving above defined three independent factors. The ANOVA for multiple linear regression was computed. Coefficient of multiple determination ($R^2$) was found to be highly significant at 0.5% level. The partial regression coefficient of three independent factors viz. No of ponds, fingerlings supplied and No. of beneficiary were estimated and found to be -0.102, 7.201 and -0.006 respectively. Significance of this coefficients were tested through respective t-values at 1% and 5% levels. Only effects of the inputs factors, no. of ponds and fingerlings supplied was significant at 5% and 1% level of significance respectively, which clearly indicates that there was negative impact of the factor viz. No. of fishery ponds on the factor fish product. While the effect of the factor fingerlings supplied on fish product was positive and significant at 1% level, the effect of the factor No. of beneficiary was found to be insignificant, even at 5% level, on the fish product.

On the light of the above findings, it can be concluded that out of three input factors considered here, effects of only two factors. No. of ponds ($X_1$) and fingerlings supplied ($X_2$) are considerable. Since no. of ponds has negative impact on fish product and fingerlings supplied has positive impact, which is significant at 1% level, on fish product. Therefore, to increase the fish product in Nagaland, supply Rs. Lakhs of fingerlings may be increased, not the No. of fishery ponds. It is clear from the table that the value of $\beta_2$ (Regression coefficient of $X_2$) is 7.2013, that means if the increase fingerlings supplied by Rs.1(one) Lakh, the value of fish product may be increased by Rs. 7.20 Lakhs. which indicates a good returns. On the other hand, the factor No. of beneficiary $X_3$ has no significant contribution towards increasing the production of fish in Nagaland.

## ACKNOWLEDGEMENT

The authors are grateful to referee for providing useful suggestions for improving the paper.

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(Received on 16-1-2001 and revised on 18-6-2002)

The Andhra Agric. J. 49 (3&4) : 354 - 356, 2002

## Research Note

# Economic Analysis of Turmeric Processing in Duggirala Region of Guntur District

**Key Words :** Econmc Analysis, Turmeric Processing, Duggirala Region

Andhra Pradesh Contributes slightly over 50% of the total production of turmeric in India. It is largely grown by small and marginal farmers. The state produced 385.09 thousand tonnes of turmeric from 64.18 thousand hectares during 1999 - 2000. The crop is mainly grown in Nizamabad, Warangal, Guntur and Cuddapah districts. Guntur district ranks second in area and third in production, which produced 25.42 thousand tonnes from 4.24 thousand hectares. Turmeric is extensively used in the preparation of tasty curried dishes by all classes of people for its typical flavour and colour. It is also used as dye in certain cotton textiles, in medicine and cosmetics (Ridly, 1983).

Like most other commercial crops, turmeric is also not ready for the market soon after harvest. It requires processing by way of boiling, drying, polishing and pulverising etc. before disposal. Turmeric is harvested in 7-9 months depending upon the variety. Usually harvesting is done from January to March. Turmeric is processed traditionally by boiling followed by Sun drying and further processing i.e. polishing, grading, milling, sieving and packaging is carried out by the processors. It is generally felt that primary producers are not able to realise their due share in Consumer's price, while the consumers pay higher prices for the products. Lack of proper storage and processing facilities in rural areas compel the farmers rely heavily on middlemen to dispose their products. Hence an attempt has been made in Guntur district of Andhra Pradesh to study the economics of processing.

The primary data was collected during May 2001 from sample farmers and also from 10 randomly chosen turmeric processing units located in Duggirala region of Guntur district from 13 units. Tabular analysis was employed to workout costs and returns of the turmeric processing and to estimate the profitability.

Economic analysis of turmeric processing is shown in the tables from 1 to 5. As the turmeric produce undergoes more and more transformation through processing, the retail price of the final product increases and the share of the producer in consumer's rupee reduces. If the farmer sells the raw turmeric, it costs very less i.e. at Rs. 250 qt $^{-1}$ which is not remunerative to the producer as there is heavy expenditure involved in the production and moreover lot of personal attention is also required. If the farmer processes the turmeric product at farm level i.e. boiling, drying, then earns a net profit of Rs. 1210 per tonne due to increased value addition (Table 2). If the product is processed at processor's level, the retail price of the final product increases and the share of the producer in consumer's rupee reduces. Value addition due to processing of turmeric produce at processor's level is Rs. 1860 per tonne (Table 4). Hence there is a gap between processing of turmeric at producer's level and processor's level to the tune of Rs. 650 per tonne (Table 5). These results are in accordance with the observations of Veerkar and Borude (1989) who found that processing mango into different products provides employment, results in considerable increase in added value.

Table 1: Labour requirement during the traditional processing operations of turmeric (Unit = 1 acre)

| Operations | No. of labour - days |
|---|---|
| Harvesting | 40 |
| Separation of finger and rhizomes | 12 |
| Preparation of processing site | 4 |
| Transportation to processing site | 8 |
| Collection of firewood | 8 |
| Curing | 50 |
| Drying and hand rubbing | 20 |
| Transportation to market | 8 |
| Cutting roots from mother rhizomes | 20 |
| Storage of mother rhizomes for seed purpose | 4 |
| Total | 174 |

Table 2.: Value addition due to traditional curing and drying (Unit = 1 acre)

| | Particulars | Quantity | Rates (Rs.) | Amount (Rs.) |
|---|---|---|---|---|
| A | Yield per 1 acre | 90 qt raw | 250/ qt | 22,500 |
| B | I) Labour requirement for processing (items 3 of table 4.1) | 98 | 40 / labour | 3,920 |
| | II) Other expenses | | | 500 |
| C | Dry turmeric obtained after processing | 18 q | 2100 / qt | 37,800 |

Net Profit due to traditional curing and drying = C - (A+B)

= 37800 - (22500 + 4420) = Rs. 10,880

Net Profit due to traditional curing and drying = Rs. 1210 per tonne

Table 3 : Expenses incurred by the processor during turmeric processing per Tonne

| Particulars | Rates ($\text{qty}^{-1}$) | Amount (Rs.) |
|---|---|---|
| Purchase tax by A.P. Govt. | 4% | 400 |
| Market committee | 1% | 100 |
| Commission | 2% | 200 |
| Hamali Expenses | | 150 |
| Polish rent charge | | 200 |
| Shortage in polishing | 40kg | 840 |
| Gunny bag for packing | | 350 |
| Grading charges | | 80 |
| Powdering rent charges | | 2000 |
| Shortage in powdering | 40kg | 840 |
| Packing charges | | 500 |
| | Total | 5660 |

Table 4 : Value addition due to processing at processor's level (Per Tonne) (Unit = 1 acre)

| Particulars | Quantity | Rates | Amount (Rs.) |
|---|---|---|---|
| Turmeric purchased from a farmer | 1 tn dry | Rs. 21000/- | 21000 |
| Processing expenses (item 1 to 11 of table 3) | | | 5660 |
| Turmeric produce obtained after processing | 920kg | Rs. 31 / kg | 28520 |

Net Profit : C - (A+B) = 28520 - (21000 + 5660) = Rs. 1860 per tonne

Table 5 : Gap between processing of turmeric at producer's level and processor's level per Tonne

| Particulars | Net profit obtained |
|---|---|
| Turmeric processed at producer's level | Rs. 1210 tonne $^{-1}$ |
| Turmeric processed at processor's level | Rs. 1860 tonne $^{-1}$ |
| Gap | Rs. 650 tonne $^{-1}$ |

It can be stated that economic analysis of turmeric process revealed that there was a gap between the processing at producer's level and processor's level to the tume of Rs. 650 per tonne.

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(Received on 31-12-2001 and revised on 9-8-2002)

The Andhra Agric. J. 49 (3&4) : 357 - 359, 2002

## Research Note

# Constraints Faced by The Members of Water Users Associations (WUAs) in Andhra Pradesh

**Key words :** Constraints, Water Users Associations

Irrigation management, an important component of many agricultural systems, is a process by which water is controlled and judiciously used in higher food production. In India, the cannal irrigation systems were mainly bureaucratically managed in which there was very meagre scope for farmers involvement. Recently the Government of Andhra Pradesh introduced an irrigation sector reform program under the APFMIS Act, 1997 to bring about farmers involvement in all aspects of irrigation management to facilitate efficient water management through farmers organizations.

WUA's are the organizations of farmers at the primary or outlet level. A large irrigation potential was created in AP state as a result of massive investment in irrigation and formation of WUA's However during the past 3 years, only about 10.07 lakh acres of gap ayacut have been bridged by WUA's in the state leaving an additional gap of 4.9 lakh acres which have yet to be bridged. This gap in the utilization of the potential created may be attributed to the constraints faced by the members of the WUA's. Only after carrying out a critical analysis of the constraints, it would be possible to decide the future strategies for reducing the problems and improving the performance of the WUA's. It was therefore, felt necessary that a comprehensive and scientific approach to study the constraints faced by the members of WUA's was essential.

Hence, the study was conducted during 2000 - 2001 in Khammam district of Andhra Pradesh which is irrigated by the Nagarjuna Sagar Left Canal Project. All the six WUAs formed on the 19th distributory canal were studied. As many as 24 villages from the six WUAs were purposively selected i.e. 2 head reach villages and 2 tail end villages from each association. 15 head reach farmers and 15 tail end farmers from each WUA were interviewed making a total of 90 head reach and 90 tail end respondents for the study. Moreover, all the six presidents of the six selected WUAs formed another category of respondents. The data was collected by using pretested structured schedule through personal interview method.

The results of the constraints faced by the water users presented in Table - 1 revealed that among the head reach farmers, majority (93.33%) expressed the constraints of very poor canal lining resulting in water wastage and scarcity. (Raji *et al.*, 1997) This was mainly because of the lack of interest shown by the executive body to undertake repairs to the canal lining. A very high per cent (90.00%) were facing the problem.

Table 1: Constraints faced by the water users n = 180

| Sl.No. | Constraints | Respondents | | | |
|---|---|---|---|---|---|
| | | Head reach (n =90) | | Tail end (n = 90) | |
| | | Frequency | Per cent | Frequency | Per cent |
| 1. | Very poor canal lining resulting in water wastage and scarcity | 84 | 93.33 | 87 | 97.66 |
| 2. | Obstruction to water flow from other users | 81 | 90.00 | 87 | 97.66 |
| 3. | Unable to maintain irrigation structures due to frequent destruction by other users | 74 | 82.22 | 81 | 90.00 |
| 4. | Unable to follow the decided operational plan (OP) | 37 | 41.11 | 42 | 46.66 |
| 5. | Incapability of the committee to solve water problems | 37 | 41.11 | 51 | 57.22 |
| 6. | In sufficient water to the fields due to poor discharge at main canal | 34 | 37.77 | 67 | 74.44 |
| 7. | High irrigation changes | 30 | 33.33 | 56 | 62.22 |
| 8. | Inadequate training | 24 | 26.66 | 38 | 42.22 |
| 9. | Wide spread unauthorised irrigation | 24 | 26.66 | 90 | 100.00 |
| 10. | Lack of technical guidance | 12 | 13.33 | 31 | 34.44 |

Table 2 : Constraints faced by the presidents

| Sl.No. | Constraints | Frequency | Per cent |
|---|---|---|---|
| a. | **Administrative constraints** | | |
| i) | Lack of farmers participation in meetings | 6 | 100.00 |
| ii) | Lack of cooperation and timely support from higher authority | 6 | 100.00 |
| iii) | Lack of farmers cooperation in works undertaken | 4 | 66.66 |
| iv) | Unable to modernize the system quickly due to delayed administrative approval | 4 | 66.66 |
| v) | Incapability of the committee members to perform their duties | 1 | 16.66 |
| vi) | Presiding over the general body or management committees meetings | - | - |
| b. | **Financial constraints** | | |
| i) | Lack of adequate funds from users or Government to improve the system | 6 | 100.00 |
| ii) | Lack of sufficient and timely loans to take up works | 5 | 83.33 |
| iii) | Problem in collection of water tax from non-localised areas | 2 | 33.33 |
| iv) | Poor maintenance and power supply to lift irrigation | 1 | 16.66 |
| c. | **Technical constraints** | | |
| i) | Insufficient technical clearance | 5 | 83.33 |
| ii) | Inadequate training on technical aspects | 3 | 50.00 |
| iii) | Lack of technical guidance | 2 | 33.33 |
| iv) | Inability to understand and operate the irrigation structures | 2 | 33.33 |
| d. | Other constraints | | |
| i) | Unable to control unauthorised irrigation at night time | 6 | 100.00 |
| ii) | Unsuitability of soils for irrigation resulting in poor water retention | 6 | 100.00 |
| iii) | Heavy damage to irrigation structures by farmers | 4 | 66.66 |
| iv) | Lack of cooperation from lascars | 2 | 33.33 |

Among the financial constraints, cent per cent expressed the constraint of lack of adequate funds from users or Government followed by 83.33 per cent who expressed the problem of lack of sufficient and timely loans to take up works. This might be because the Government did not approve to certain works proposed and therefore did not finance and the loans sanctioned were inadequate. The users also did not contributed owing to poor income.

Among the technical constraints, the major (83.33%) was insufficient technical clearance owing to the reason that many works were proposed to be undertaken but the clearance sanctioned was inadequate. Finally among the other constraints expressed, cent per cent faced the problems such as unable to keep check on widespread unauthorized irrigation at night time and unsuitability of soils for irrigation as they lead to deep water percolation, which were major problems of the region. Similar findings were reported by Mohite *et al.* (1992) and Gumaste *et al.* (1993.).

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(Received on 3-11-2001 and revised on 15-1-2002)

The Andhra Agric. J. 49 (3&4) : 360 - 362, 2002

## Research Note

# Disciplinewise Technologies Generated, and Their Utilisation by The Clientele

**Key Words :** Disciplinewise, Technologies, Utilisation, Clientele.

Indian Council of Agricultural Research (ICAR) implemented National Agricultural Research Project (NARP) with the help of World Bank to strengthen the agricultural research in State Agricultural Universities. Under this project Acharya N.G. Ranga Agricultural University (ANGRAU) strengthened its research base at regional level by providing scientific and supporting man power, infrastructure facilities, building and finance to conduct location specific, need based, production oriented research in identified agroclimatic zones.

During NARP period in ANGRAU number of technologies were generated disciplinewise and disseminated to the clientele. Hence this study was undertaken to identify the number of technologies generated by the different disciplines from 1986 to 1993 and also differences among the disciplines, and to know the number of technologies known and adopted by the farmers disciplinewise and differences in knowledge and adoption.

Studies were made in six agroclimatic zones of ANGRAU, which was functioned science inception of NARP. From the six zones seven research stations, six of them were zonal head quarters and one is lead station to the principal crop of AP Rice was selected purposively where more number of respondents were available.

Data regarding generation of technologies to the years from 1986 to 1993 were obtained from the secondary data available with the research stations. A list of farmers who regularly attended to the ZREAC meetings and acted as host farmers to Rural Agricultural Work Experience Programme, students was prepared stationwise. From this list 100 farmers were selected, by using proportionate random sampling method separate schedules were developed for each station and knowledge and adoption of farmers were obtained separately for each station and total scores of the seven stations were presented. The number of technologies known and adopted were expressed in frequencies and percentages.

With the help of chi-square test significant differences among the various disciplines with regard to number of technologies generated, farmer's knowledge and adoption were worked out.

From the data (Table) regarding the disciplinewise technologies generated, known and adopted by the farmers during the period 1986 to 1993.

Table : Disciplinewise technologies developed, knowledge and adoption of these technologies by the farmers in different research stations.

| Discipline | TD | TK | TA |
|---|---|---|---|
| Plant breeding | 48 | 20<br>(41.66) | 19<br>(39.58) |
| Entomology | 48 | 22<br>(45.88) | 21<br>(43.75) |
| Agronomy | 20 | 3<br>(15.00) | 3<br>(15.00) |
| Plant pathology | 9 | 0 | 0 |
| Plant Physiology | 0 | 0 | 0 |
| Soil Science | 10 | 2<br>(20.0) | 2<br>(20.0) |
| Post harvest technology | 1 | 0 | 0 |
| Agril. Engineering | 0 | 0 | 0 |
| Agril. Economics | 0 | 0 | 0 |
| Horticulture | 0 | 0 | 0 |
| Extension | 0 | 0 | 0 |
| Value | 27.92** | 19.66** | 22.97** |

Note : TD = Techonologies developed
TK = Technologies known to the farmers
TA = Technologies adopted by the farmers
** Significant $X^2$ = 16.81 at 0.01 probability level
Figures in the parenthesis indicate percentage.

It can be observed that the plant breeding and entomology disciplines had generated 48 technologies each followed by Agronomy (20), Soil Science (10), plant pathology (9) and post harvest technology (1) and rest of the disciplines were not generated any technologies.

As the $x^2$ value was highly significant (27.92) showed significant variation among the disciplines in generation of technologies. In disciplines like plant Breeding and Entomology a good percentage (42 to 46%) of technologies were known to the farmers, while it was low in Agronomy (15%) and Soil Science (20%).

There was significant difference among the knowledge of farmers with regard to technologies generated by the disciplines in research stations ($x^2$ = 19.66).

The painful part was that disciplines like Plant Pathology, Plant Physiology, Post Harvest Technology, Agricultural Engineering, Agricultural Economics, Extension and Horticulture did not make any impact with regard to technology generation and making the farmers aware of these technologies.

Maximum number of farmers adopted Entomology Techniques (43.75%), followed by Plant Breeding (39.58%), Soil Science (20%) and Agronomy (15.00%). The question of adoption or non adoption by the farmers with regard to disciplines like Agricultural Engineering, Post Harvest Technology, Economics, Extension and Horticulture did not arise, any of these disciplines had not generated any technologies at all.

There was significant differences ($x^2$ = 22.97) among the disciplines in adoption of these technologies by the farmers.

It can be concluded that quite a large amount of technologies were generated at these seven research stations. Disciplines like Plant Breeding, Entomology and Agronomy generated more number of technologies. Less number of technologies were known and adopted by the farmers.

Entomology and Plant Breeding technologies were known and adopted by large number of farmers, than other discipline's technologies.

Significant variation was observed among the disciplines in generation of technologies, knowledge and adoption of these technologies by the farmers.

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(Received on 1-7-2000 and revised on 15-11-2001)

The Andhra Agric. J. 49 (3&4) : 363 - 366, 2002

## Research Note

# A Study on The Extent of Participation of Farm Women in Agriculture and Allied Activities in Chittoor District of A P

**Key words :** Participation, Farm Women, Allied Activities Agriculture,

Women play a significant role in agriculture and allied activities. As cultivators, agricultural labourers, house wives they constitute a sizeable section of work force. Women's active role in farm related activities within and outside the household is pervasive throughout the third world. So far as farm activities are concerned, women participate in almost all activities right from preparatory tillage to harvesting, but the contribution made by them is often not adequately recognized and appreciated. In the national conference on women in agriculture, many scientists pointed out the inadequacies in research studies on women and their participation in agriculture. Many researchers were of the opinion that to involve this vast majority in development process, a clear understanding of their nature and type of participation, in various agriculture and allied activities is essential.

Ex-post-facto research design was followed in the study from Chittoor district in Andhra Pradesh was purposively selected. Two mandals from district viz., Chandragiri and Sodam were selected randomly. Two villages from each mandal, constituting to a total of four villages viz., Chandragiri, Ithepalli, Sodam and Ammagaripalli were selected randomly. A sample of 120 farm women as respondents were selected from four villages by employing proportionate random sampling method. An interview schedule was developed for collecting data. Data on different agriculture and allied activities was gathered, analysed and interpreted statistically.

It is clear (Table 1) that majority (67.50%) of the respondents had medium extent of participation, while 16.67 per cent had high and 15.83 per cent had low extent of participation in agriculture and allied activities.

Table 1: Distribution of Respondents According to Their Extent of Participation in Agriculture and Allied Activities

n = 120

| Extent of Participation | Frequency | Percentage |
|---|---|---|
| Low | 19 | 15.83 |
| Medium | 81 | 67.50 |
| High | 20 | 16.67 |
| Total | 120 | 100.00 |
| Mean : 20.62 | | S.D : 9.86 |

Table 2: Distribution of Respondents According to Their Extent of Participation in Agriculture and Allied Activities.

| Activities | Extent of Participation | | | | | |
|---|---|---|---|---|---|---|
| | FP | | PP | | NP | |
| | F | P | F | P | F | P |
| **a) Agriculture Activities** | | | | | | |
| 1 Land preparation | 0 | 0.00 | 28 | 23.33 | 92 | 76.67 |
| 2 Manuring | 12 | 10.00 | 59 | 49.17 | 49 | 40.83 |
| 3 Seed treatment | 9 | 7.50 | 35 | 29.17 | 76 | 63.33 |
| 4 Sowing | 88 | 73.33 | 8 | 6.67 | 24 | 20.00 |
| 5 Transplanting | 69 | 57.50 | 3 | 2.50 | 48 | 40.00 |
| 6 Gap filling | 64 | 53.33 | 3 | 2.50 | 53 | 44.17 |
| 7 Fertilizer application | 8 | 6.67 | 63 | 52.50 | 49 | 40.83 |
| 8 Weeding | 82 | 68.33 | 6 | 5.00 | 32 | 26.67 |
| 9 Irrigation | 6 | 5.00 | 27 | 22.50 | 87 | 7.50 |
| 10 Plant protection | 2 | 1.67 | 48 | 40.00 | 70 | 58.333 |
| 11 Watch and ward | 4 | 3.33 | 24 | 22.00 | 92 | 76.67 |
| 12 Harvesting of crop | 80 | 66.67 | 9 | 7.50 | 31 | 25.83 |
| 13 Threshing | 7 | 5.83 | 35 | 29.17 | 76 | 63.33 |
| 14 Winnowing | 33 | 27.50 | 23 | 19.17 | 64 | 53.33 |
| 15 Drying of produce | 35 | 29.17 | 13 | 10.83 | 72 | 60.00 |
| 16 Transporting and storage | 37 | 30.83 | 13 | 10.83 | 70 | 58.33 |
| 17 Marketing | 12 | 10.00 | 13 | 10.83 | 95 | 79.17 |
| **b) Allied activities** | | | | | | |
| 1. Dairy | | | | | | |
| i) Feeding the aminals | 44 | 36.67 | 36 | 30.00 | 40 | 33.33 |
| ii) Grazing | 73 | 60.83 | 3 | 2.50 | 44 | 36.67 |
| iii) Cleaning the cattle shed | 51 | 42.50 | 20 | 16.67 | 49 | 40.83 |
| iv) Milking | 72 | 60.00 | 4 | 3.33 | 44 | 36.67 |
| v) Marketing of milk | 61 | 50.83 | 6 | 5.00 | 53 | 44.17 |
| vi) Any other (Cleaning animals) | 35 | 29.17 | 0 | 0.00 | 85 | 70.83 |
| 2. Poultry | | | | | | |
| i) Feeding | 7 | 5.83 | 0 | 0.00 | 113 | 94.17 |
| ii) Watering | 6 | 5.00 | 0 | 0.00 | 114 | 95.00 |
| iii) Marketing of poultry produce | 1 | 0.83 | 1 | 0.83 | 118 | 98.33 |
| iv) Cleaning of poultry shed | 2 | 1.67 | 0 | 0.00 | 118 | 98.33 |
| v) Any other (sprinkling water) | 19 | 15.83 | 0 | 0.00 | 101 | 84.17 |
| 3. Sheep / goat rearing | | | | | | |
| i) Feeding | 2 | 1.67 | 0 | 0.00 | 118 | 98.33 |
| ii) Grazing | 2 | 1.67 | 0 | 0.00 | 118 | 98.33 |
| iii) Marketing | 0 | 0.00 | 0 | 0.00 | 120 | 100.00 |
| iv) Cleaning the shed | 0 | 0.00 | 0 | 0.00 | 120 | 100.00 |
| v) Health care | 2 | 1.67 | 0 | 0.00 | 118 | 98.33 |
| 4. Apiculture | 0 | 0.00 | 0 | 0.00 | 120 | 100.00 |
| 5. Sericulture | 2 | 1.67 | 0 | 0.00 | 118 | 98.33 |
| 6. Pisciculture | 0 | 0.00 | 0 | 0.00 | 120 | 100.00 |
| 7. Piggery | 0 | 0.00 | 0 | 0.00 | 120 | 100.00 |
| 8. Mushroom cultivation | 0 | 0.00 | 0 | 0.00 | 120 | 100.00 |
| 9. Home science | 114 | 95.00 | 6 | 5.00 | 0 | 0.00 |
| 10. Cottage industry | 0 | 0.00 | 0 | 0.00 | 120 | 100.00 |

FP : Full Participation PP : Partial Participation NP : Non Participation F: Frequency P: Percentage

The possible reason for the above result might be due to the existence of value systems, still in villages viz., certain activities like threshing, winnowing etc., are performed only by lower caste people. Ploughing of land, marketing, watch and ward, manuring, irrigating, fertilizer application, plant protection are done by male farmers as they were laborious tasks. Women's participation in these activities was only partial. Some farm women being economically affluent had no necessity to participate in agriculture and allied activities. This finding was in accordance with the findings of Reddy (1990) and Sreedevi (1996).

It was observed (Table 2) that out of seventeen agricultural activities, majority of respondents had full participation in sowing (73.33%), weeding (68.33%), harvesting of crop (66.67%), transplanting (57.50%) and gap filling (53.33%). The reason could be that, these activities were earmarked as women activities since ages in rural areas and they are habituated to do them. Partial participation was observed in activities like fertilizer application (52.50%) and manuring (49.17%). This might be due to the reason that farm women had only supportive role in these activities. Majority of farm women had no participation in activities like marketing (79.17%), preparatory tillage (76.67%), watch and ward (76.67%), irrigation (72.50%), seed treatment (63.33%), threshing (63.33%), drying of produce (60.00%), plant protection (58.33%), transporting and storage of produce in godown/ house (58.33%) and winnowing (53.33%). This might be because some of these activities are labourious and require enormous physical energy which women could not cope up, some of them are done by lower caste people, some activities demand skill on the part of women which they are lacking, some activities involve dealing with traders and workers which might be difficult for farm women. The findings are in line with findings of Sagar (1989).

With regard to allied activities majority of women had full participation in Home Science activities (95.00%), dairy activities like taking the animals for grazing (60.83%), milking (60.00%), marketing of milk (50.83%), cleaning of cattle shed (42.50%) and feeding the animals (36.67%). This was because dairy industry being well developed in Chittoor district, women apart from their primary household activities are habituated to do dairy activities as part of their daily routine work. Partial participation was noticed in feeding the animals (30.00%) under dairy. No participation was observed in activities like marketing / selling (100.00%) and cleaning the shed (100.00%) under sheep / goat rearing, apiculture (100.00%), pisciculture (100.00%), piggery (100.00%), mushroom cultivation (100.00%), cottage industry (100.00%), marketing of poultry produce (98.33%), cleaning of poultry shed (98.33%), feeding (98.33%), taking animals for grazing (98.33%) and health care (98.33%) under sheep / goat rearing, sericulture (98.33%) and watering (95.00%). This was because very few or none of the respondents had these activities. The findings regarding dairy activities are in conformity with the findings of Sagar (1989).

It can be concluded that there is a need for altering the existing value systems in the villages by organising more number of training programmes and demonstrations to improve their knowledge and skill in the use of equipment in agriculture and allied activities and thereby enhancing their participation. Employing more number of women extension workers helps in developing good rapport which inturn will help them to participate to the maximum extent in agriculture and allied activities.

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(Received on 15-5-2001 and revised on 27-11-2002)

The Andhra Agric. J. 49 (3&4) : 367 - 370, 2002

## Research Note

# Relationship of Profile Characteristics with Time Management of Agricultural Graduates

**Key words :** Profile Characteristics, Agricultural Graduates, Time Management.

Time is a unique resource, which cannot be created in anyway. Neither can it be accumulated like money in bank nor does it appreciate or depreciate for itself like shares. Time as a resource is important in one's life, as it is an organising medium for human life and a common denominator within which every one operates. Unlike resources such as, money and other material goods, time enjoys certain unique characteristics. They are, its availability in equal quantity to every one and its non-amenability for accumulation to another day. Therefore, an effective time manager realises and recognises the importance of time resource and distributes it in his/her days activities. Time cannot be manufactured nor can it be renewed. However, control over the use of his time can ensure that this scarcest of all the resources is applied to the most rewarding of the tasks. Davey (1994) inferred that teachers are in the best position to guide students in developing self - control activities by including time planning assistance with regular assignments.

As more and more people are becoming aware of the importance of time, they are using innovative methods to cut down on time wastage. It is evident that unless you yourself make an effort to manage time, time cannot be managed. In other words, management differs from person to person. In short, it could be called "self management".

The study was purposively conducted in three colleges of Acharya N G Ranga Agricultural University (ANGRAU) viz., Bapatla, Rajendranagar and Tirupati as Post Graduate Courses offering in the above campuses only. Ex-post-facto research design was used in this study. First year Post - graduate students from the faculty of Agriculture of the selected three colleges constituted the sample of the study. Thus, the list of first M.Sc. (Ag) students from selected three colleges was obtained and their names were alphabetically arranged and 15 boys and 15 girl students were randomly selected to be included as a sample for the study from each college. Thus, the total sample for the study constituted 45 boys and 45 girl students from these three colleges.

Correlation and multiple linear regression analysis was carried out to find out the relationship between independent variables and the time management.

The relational analysis about girl students clearly revealed that the computed "r" value of socio - economic status (0.408), motivational forces for admission (0.312), teacher - student interaction (0.270) were found to be positively significant at 0.01 level of probability while aspirations after graduation (0.197) was found to be positively significant at 0.05 level of probability and the remaining independent variables were found to be non-significant with time management. Out of eleven independent variables fitted in the regression equation viz., socio - economic status, motivational forces for admission, teacher - student interaction were found to be positively significant at 0.01 level of probability and financial help was found to be positively significant at 0.05 level of probability. The value of co-efficient of multiple determination ($R^2$) was 0.511 indicating that all the independent variables could explain about variation in the dependent variable to the extent of 51.10 per cent. The "F" test of statistic indicated that this variation was significant at 0.01 level of probability.

In the case of boy students, it is vivid from the Table 1 that the "r" values of socio - economic status (0.634), place of study (0.440), interference of teacher in student time management (0.398), teacher - student interaction (0.408), academic environment (0.315), student perception on evaluation pattern (0.308) were found to be positively significant at 0.01 level of probability and the other independent variables were found to be non - significant with time management. Out of eleven independent variables fitted in the regression analysis viz., socio - economic status, aspirations after graduation and teacher - student interaction were found to be positively significant at 0.01 level of probability. The value of coefficient of multiple determination ($R^2$) was 0.516 indicating that all the independent variables could explain about variation in the dependent variable to the extent of 51.60 per cent. The "F" test of statistic indicated that this variation was significant at 0.01 level of probability.

The data in respect of pooled sample clearly indicated that the "r" values of socio - economic status (0.502), student perception on evaluation pattern (0.286) were found to be positively significant at 0.01 level of probability and place of study (0.199), interference of teacher in student time management (0.226), academic environment (0.245) and teacher - student interaction (0.250) were found to be significant at 0.05 level of probability and the remaining variables were found to be non-significant with time management. Out of eleven independent variables fitted in regression analysis socio - economic status, motivational forces for adminission and aspirations after graduation were found to be positively significant at 0.01 level of probability, while place of study, teacher - student interaction, academic environment and student perception on evaluation pattern were found to be positively significant at 0.05 level of probability. The value of coefficient of multiple determination ($R^2$) was found to be 0.545 indicating that all variables could explain about variation in the dependent variable to the extent of 54.50 per cent. The "F" test of statistic indicated that this variation was significant at 0.01 level of probability.

The single variable correlation analysis from Table 1 inferred that variables like socio - economic status, place of study, interference of teacher in student time management, teacher - student interaction, academic environment and student perception on evaluation pattern were found to be positive and significantly correlated with time management. These results indicated that the student with upper socio - economic status would have received better guidance in terms of scheduling of time by their educated parents and socio - politico participation which inturn helped to manage their time wisely.

Table 1: Correlation and multiple linear regression analysis of independent variables with Time Management.

| S.No. | Variable | Grils (n = 45) | | | | Boys (n = 45) | | | | Pooled sample (n = 90) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | "r" value | Regression coefficient | SE | "t" value | "r" value | Regression coefficient | SE | "t" value | "r" value | Regression coefficient | SE | "t" value |
| 1 | Medium of instruction ($X_1$) | 0.163NS | 1.6309NS | 1.4920 | 1.093 | 0.144NS | 7.1668NS | 1.9704 | 0.364 | 0.103NS | 9.9698NS | 18.06 | 0.821 |
| 2 | Social economic status ($X_2$) | 0.408** | 7.5823** | 1.8945 | 4.002 | 0.634** | 8.5812** | 3.3013 | 3.599 | 0.502** | 7.6540** | 1.5764 | 4.855 |
| 3 | Financial help ($X_3$) | 0.130NS** | 1.3216* | 7.3704 | 1.793 | -0.114NS | 7.8136NS | 9.2568 | 0.844 | 0.001NS | 8.3736NS | 5.6510 | 1.482 |
| 4 | Motivational forces for admission ($X_4$) | 0.312** | 3.1567 | 1.0402 | 3.835 | -0.019NS | 3.9039NS | 1.1255 | 0.347 | 0.155NS | 17.4950** | 7.3936 | 2.366 |
| 5 | Aspirations after graduation | 0.197* | 5.0404NS | 4.7475 | 1.062 | 0.113NS | 4.3984** | 5.4225 | 2.811 | 0.189NS | 7.2088** | 3.5240 | 2.046 |
| 6 | Place of study ($X_6$) | -0.017NS | 0.8081NS | 3.0466 | 0.256 | 0.440** | 0.7215NS | 4.4898 | 0.161 | 0.199* | 0.7569NS | 2.3557 | 0.321 |
| 7 | Interference of Teacher in student time management ($X_7$) | 0.037NS | 0.0803NS | 2.7010 | 0.031 | 0.398** | 3.4838NS | 2.5886 | 1.346 | 0.226* | 0.6770NS | 1.8102 | 0.374 |
| 8 | Teacher - student interaction ($X_8$) | 0.270* | 3.9393** | 1.7088 | 2.305 | 0408** | 0.7359** | 1.8198 | 3.404 | 0.250* | 1.8744** | 1.1199 | 1.988 |
| 9 | Academic environment ($X_9$) | -0.146NS | -1.3123NS | 2.0199 | -0.652 | 0.315** | 1.5457NS | 1.6790 | 0.921 | 0.245* | 1.7528* | 1.2156 | 1.948 |
| 10 | Information seeking behaviour ($X_{10}$) | 0.005NS | 2.2910NS | 2.8558 | 0.292 | 0.062NS | 8.1379NS | 8.2174 | 0.990 | 0.019NS | 3.4572NS | 5.5647 | 0.621 |
| 11 | Student perception on evaluation pattern ($X_{11}$) | 0.157NS | 1.8720NS | 1.4746 | 1.4746 | 0.308** | 1.1683NS | 1.6740 | 0.698 | 0.286* | 1.8699* | 1.0358 | 1.962 |
| | $R^2$ | | 0.511 | | | 0.516 | | | | | 0.545 | | |
| | F | | 3.13* | | | 3.20* | | | | | 5.45* | | |

* Significant at 0.05 level of probability ** Significant at 0.01 level of probability NS = non - significant

Academic environment established positive and significant relationship with time management. It might be due to the fact that good academic environment creates the suitable learning situation and students may utilize their time effectively. Good academic environment paves way for effect utilization of their time. Pioneer National Institute ICAR also recognized the ANGRAU as one of the best institute in terms of research, extension and education during 1999 - 2000. Place of study have also found to be established a positive and significant relationship with time management. It might be due to the fact that the persons coming from "Urban" background will have better exposure compared to non - urban students. They could have received a better guidance in terms of scheduling activities, maintaining good health, as ill health is a time waster. Interference of teacher in student time management exhibited a positive and significant relationship with time management. It might be due to the fact that inspite of the interference of teacher in the student's time they could able to manage their time better because of their socio - economic status and aspirations. Teacher - student interaction also shows positive and significant relationship with time management. Because of interaction, the student could rectify his doubts and receive proper guidance on time scheduling and future plans. Therefore, positive relationship was observed. Student perception on evaluation pattern was also found to establish positive and significant relationship with time management. If the student perceive positively towards evaluation pattern like internal and external grading, examinations they might have managed their time efficiently, with a view to excel others through the higest OGPA.

An overview of pooled sample revealed that scio-economic status, motivational forces for admission, aspiration after graduation, place of study, teacher student interaction and student perception on evaluation pattern, were found to be contributing significantly towards the time management by the respondents. All the variables put together could explain the variation in dependent variable to the extent of 54.50 per cent. One unit increase in socio-economic status could increase time management by 7.65 units and one unit change in motivational forces for admission, aspirations after graduation, place of study, teacher - student interaction and student perception on evaluation pattern would cause 17.49 per cent, 7.20 per cent, 0.75 per cent, 1.83 per cent and 1.86 per cent units change respectively in time management.

It is obvious that out of 11 variables six variables viz., socio-economic status, place of study, interference of teacher in student time management, teacher - student interaction, academic environment and student perception on evaluation pattern were found to be positively and significantly correlated with time management. All the variables put together could explain the variation in time management to the extent of 54.50 per cent.

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(Received on 30-6-2002 and revised on 22-11-2002)

The Andhra Agric. J. 49 (3&4) : 371 - 372, 2002

# Research Note

# Effect of Seed Treatment on Green Gram Seed Mycoflora

**Key words :** Seed Treatment, Green Gram, Mycoflora

The efficacy of seed dressing fungicides against seed mycoflora has been evaluated with a number of pulse crops, but little information about the effect of seed dressing fungicides on the mycoflora associated with mung bean seed is available. The present investigation was undertaken with a view to assess the relative efficacy of a few seed dressing fungicides. So that the most effective fungicide which may eliminate the maximum number of mycoflora associated with the seeds of mung bean could be recommended.

25 g of mung seeds were taken in a flask of 250 ml capacity and required quantity of the test fungicides were mixed thoroughly by shaking the flask for 10 minutes in order to get the fungicides distributed uniformly on seed surface. The test fungicides used were Captan, Carbendazim. Zride, Vitavax, Mancozeb and Copper oxychloride.

The treated seeds of each treatment and untreated seeds were tested for the association of mycoflora under both agar plate method and standard blotter method by adopting the recommended method. The petriplates were incubated at 25°c for 5 days and the colonies of the fungi growing on seeds were daily recorded.

Results presented in tables, show that moong seed fungi can effectively be controlled by the use of captan seed dresser under both standard blotter method and agar plate method. Fungal colony counts varied from "o" to 70% in different fungicide treated seeds. The highest fungal colonies were obtained from the seeds treated with vitavax, where as there did not develop any fungal colony in captan treated seeds.

Out of the six fungicides used as seed treatments, captan eliminated all the fungi associated with mung seeds. Ziram and copper oxychloride also gave complete control of all the fungi associated with the seeds except *A. niger* and *A. flavus* and *Penicillium* in both agar plate method and standard blotter method. Blitox and Bavistin were comparatively less effective because the seeds treated with these two fungicides grown on the petriplates had a few colonies of *Rhizopus* sp., *Aspergillus* sp. *Helminthosporium* sp., *Penicillium* sp., and *Colletotrichum* sp. fungal colonies were very limited. Among the rest of the test fungicides, Dithane M-45 and Vitavax were found least effective.

Almost similar results have been reported earlier. The reports of Suhag (1975) showed

Table : Per cent increase of fungi associated with the seed treated with fungicides under both agar plate method and standard blotter method

| Name of the fungus | Captan | | Mancozeb | | Carbendazim | | Copper oxy chloride | | Ziram | | Carboxin | | Control | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | APM | SBM | APM | SBM | APM | SBM | APM | SBM | APM | SBM | APM | SBM | APM | SBM |
| *Rhizopus sp.* | - | - | - | - | 16.66 | 21.66 | - | - | - | 15.0 | 11.66 | - | 10.00 | 20.00 |
| *A. niger* | - | 1.67 | 21.66 | 18.33 | 8.33 | 10.00 | 20.0 | 18.33 | 10.0 | 2.67 | 13.33 | 26.66 | 23.30 | 28.33 |
| *A. flavus* | - | 1.67 | 15.00 | 11.66 | 13.33 | - | 07.0 | 3.33 | 5.0 | - | 23.33 | 18.67 | 15.33 | 16.66 |
| *Colletotrichum sp* | - | - | - | - | - | - | - | - | - | - | 1.66 | - | - | - |
| *Helminthosporium sp.* | - | - | - | - | - | - | - | 5.33 | - | - | - | 5.33 | 8.33 | - |
| *Botryodiplodia sp.* | - | - | 5.00 | - | - | - | - | - | - | - | - | - | - | - |
| *Penicillium sp.* | - | - | - | - | - | - | - | - | 5.0 | - | 8.33 | 8.00 | 6.66 | 5.0 |
| *Fusarium sp.* | - | - | 6.66 | 6.66 | - | 5.00 | - | - | - | - | 11.66 | 5.33 | 26.66 | 18.00 |
| | 0 | 3.34 | 48.32 | 34.99 | 38.32 | 31.66 | 27.0 | 26.99 | 20.0 | 17.67 | 69.97 | 63.99 | 90.31 | 87.99 |

that seed treatments with captan and other fungicides were effective in reducing the number of fungi associated with greengram seed. Sharma *et al.* (1975) Jhooty and Bains (1972) and Quaiser and Ahmed (1987) found that Dithane M-45 and vitavax were completely ineffective in reducing the number of fungi associated with greengram seed.

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(Received on 6-12-2000 and revised on 12-4-2001)

The Andhra Agric. J. 49 (3&4) : 373 - 374 , 2002

## Research Note

# Incidence of *Aspergillus niger* v. Teighem In Groundnut Seeds Stored for Different Periods

**Key words :** Aspergillus niger, groundnut.

Groundnut is an important oilseed crop of the world. The seeds of groundnut are affected by many fungi during storage which result in decrease or complete failure of seed germination. Deterioration of groundnut seeds during storage due to *Aspergillus niger v.* Teighem has been reported (Dange *et al.*, 1985, Dange and Patel, 1984). Keeping in view the damage caused by this fungus during storage the present study was undertaken to find the effect of storage period on the incidence of *Aspergillus niger.*

Table : Isolation of Aspergillus niger from seeds of different varieties of groundnut

| Variety | Per cent incidence of *Aspergillus niger** | |
|---|---|---|
| | Standard Blotter method | Agar plate method |
| DRG - 12 | 16.67 | 66.67 |
| | (23.86) | (54.78) |
| Gulabi | 26.67 | 60.00 |
| | (30.29) | (50.85) |
| JL - 24 (N) | 30.00 | 89.99 |
| | (33.00) | (74.81) |
| JL - 24 | 36.67 | 63.33 |
| | (37.22) | (52.77) |
| K - 150 | 46.67 | 70.00 |
| | (43.08) | (56.99) |
| K - 134 | 20.00 | 66.67 |
| | (26.07) | (55.07) |
| Somnath | 26.67 | 79.99 |
| | (30.99) | (67.88) |
| TAG - 4 | 43.33 | 83.33 |
| | (41.15) | (70.59) |
| TCGS - 320 | 30.00 | 56.67 |
| | (33.00) | (48.93) |
| TMV - 2 | 33.33 | 73.33 |
| | (35.22) | (59.00) |
| TPT - 4 | 46.67 | 66.67 |
| | (43.08) | (55.07) |
| SEM ± | 3.23 | 6.54 |
| CD (0.05) | 9.47 | 19.19 |

* Mean of three replications

Figures in parenthesis are arc sine transformed values.

Groundnut seeds of the variety TMV-2 were used in the present study. Seeds were stored in cloth bags at room temperature (28 ±1°C) for different periods viz., 30, 60, 90, 120 and 150 days respectively. *Aspergillus niger* associated with the seed samples stored for different periods was estimated using both standard blotter and agar plate method. For each storage period three replications were maintained. Observations were made on the incidence of *Aspergillus niger* and expressed as per cent incidence.

$$\text{Per cent incidence} = \frac{\text{No. of seeds colonized in each plate by } \textit{Aspergillus niger}}{\text{Total number of seeds}} \times 100$$

The results (Table) reveal that the incidence of *Aspergillus niger* increased with increase in storage period. *Aspergillus niger* was found associated with the seed at all periods of storage. A maximum of 72.5 per cent incidence was recorded at 150 days of storage and a minimum of 62.5 per cent incidence was recorded at 30 days of storage. Though there was increase in the incidence of *Aspergillus niger* with increase in storage period, the increase was significant between 30 and 150 days of storage. The relative abundance of *Aspergillus niger* in the seed stored for 150 days in the present study might be attributed to the depleted moisture of the seed (Lokesh and Hiremath, 1983). The results obtained in the present study are in conformity with findings of Clarke *et al.* 1966; Clarke *et al.*, 1968 and Dorworth and Christensen, 1968.

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(Received on 5 -2-2001 and revised on 25-11-2002)

The Andhra Agric. J. 49 (3&4) : 375 - 376, 2002

## Research Note

# Agroeconomic Feasibility of Pulse Based Cropping Systems Under Rainfed Conditions in K.G. Zone of Andhra Pradesh

**Key Words :** Agroeconomic, Pulse Based Cropping,Rainfed in K.G. Zone.

In dry lands, mono - cropping was a common practice. Double cropping is one of the methods to increase the cropping intensity and the overall productivity. Double cropping under dryland conditions was found feasible by a number of workers. (Jain and Reddy, 1981; Giri and Gangasaran, 1984; Raju and Reddy, 1990 and Padhi *et al.*, 1993). Commercial crops like cotton and chillies cultivated extensively in Andhra Pradesh under rainfed conditions over the years led to soil ill health, pest and disease epidemics, stagnant or lowering of yields. The cost of production is increasing year after year. Hence, there is a need to rotate these crops with alternate double cropping sequences. The bimodel rainfall pattern of this region can be efficiently utilized to raise two crops - one in *Kharif* and another in *rabi* season thereby increasing cropping intensity. Venkateswarlu (1979) reported that double cropping is possible with early maturing crops in regions having 750 - 900 mm rainfall with soil moisture storage capacity of 150 mm and above.

Field experiments were conducted during *kharif* and *rabi* seasons of 1995 - 96 and 1996 - 97 at Regional Agricultural Research Station, Lam, Guntur. The soils are clayey in texture, low in nitrogen, medium in phosphorus and high in pottassium with a pH of 8.2. Urdbean (LBG 20) and mungbean (LGG 407) were grown in *kharif* in large strips. In *rabi* season, soybean (JS 335), Coriander (CS4), chickpea (ICCV10) and pigeonpea (ICPL85063) were grown after the harvest of *kharif* crops. Crops were grown entirely under rainfed conditions. *Rabi* crops were benefited by North - East monsoon rains. A rainfall of 477.4 and 604.7 mm was recorded in 30 and 26 rainy days during *kharif* and 2.2 and 83.5 mm in Nil and 4 rainy days in *rabi* during 1995 - 96 and 1996 - 97 respectively.

*Kharif* crops were sown on 13th July and 10th July and harvested on 4th October and 21st September during 1995 - 96 and 1996 - 97 respectively. *Rabi* crops were sown on 3rd November and 28th Oct during 1995 - 96 and 1996 - 97 respectively. *Rabi* crops viz., soybean (1.2.96 and 6.1.97); coriander (5.2.96 and 27.1.97); chickpea (15.2.96 and 24.2.97) and pigeonpea (11.3.96 and 10.3.97) were harvested on the dates mentioned in the parenthesis.

Mungbean recorded higher yields over urdbean in *kharif* season during both the years (Table 1). The yield recorded by the *rabi* crops after *kharif* mungbean were superior to the yield of crop sequences followed by urdbean. Among the *rabi* crops, however, pigeonpea gave maximum yield (2086 kg ha$^{-1}$) in 1995 - 96 when

Table : Productivity and economics of different sequential cropping systems in black soils under rainfed conditions

| Treatments | Grain Yield (Kg ha$^{-1}$) | | | | Gross returns (Rs ha$^{-1}$) | | Mean (Rs ha$^{-1}$) | Cost Benefit raio |
|---|---|---|---|---|---|---|---|---|
| | 1995 - 96 | | 1996 - 97 | | 1996 - 97 | 1996 - 97 | | |
| | *kharif* | *rabi* | *kharif* | *rabi* | | | | |
| Urdbean - Soybean | 273 | 306 | 348 | 1014 | 7974 | 16409 | 12191 | 0.62 |
| ,, Coriander | 273 | 671 | 348 | 729 | 15650 | 17924 | 16787 | 0.87 |
| ,, Chickpea | 273 | 1252 | 348 | 1916 | 19938 | 29256 | 24597 | 1.25 |
| ,, Pigeonpea | 273 | 2086 | 348 | 1656 | 46639 | 39384 | 43011 | 1.79 |
| ,, Soybean | 285 | 367 | 400 | 1066 | 7945 | 16665 | 12305 | 0.64 |
| ,, Coriander | 285 | 702 | 400 | 786 | 15507 | 18580 | 17043 | 0.90 |
| ,, Chickpea | 285 | 1351 | 400 | 2179 | 20487 | 32148 | 26317 | 1.38 |
| ,, Pigeonpea | 285 | 2031 | 400 | 2166 | 44896 | 49326 | 47111 | 2.02 |
| S.Em ± | | | | | 1077 | 810 | | |
| C.D. (0.05) | | | | | 3168 | 2997 | | |

Note : Price of Urdbean seed -- Rs. 18.00 kg$^{-1}$
Price of Mungbean seed -- Rs. 15.00 kg$^{-1}$
Price of Coriander seed -- Rs. 16.00 kg$^{-1}$
Price of Chickpea seed -- Rs. 12.00 kg$^{-1}$
Price of Pigeon pea seed -- Rs. 12.00 kg$^{-1}$

grown after urdbean followed by pigeonpea (2031 kg ha$^{-1}$) that succeeded mungbean. However, during 1996-97, chickpea recorded maximum grain yield (2179 kg ha$^{-1}$) when grown after mungbean which was closely followed by pigeonpea (2166 kg ha$^{-1}$) after mungbean.

The same trend was reflected in the gross returns. During 1995 - 96 a maximum gross return of Rs. 46.639ha$^{-1}$ was obtained by urdbean - pigeonpea sequence followed by mungbean - pigeonpea (Rs. 44, 896 ha$^{-1}$) sequence. In 1996 - 97, maximum gross return of Rs. 49,326 ha$^{-1}$ was obtained from mungbean - pigeonpea followed by urdbean - pigeonpea (Rs. 39,384 ha$^{-1}$).

Mungbean - pigeonpea cropping sequence was the most remunerative system with a gross income of Rs. 47,111 ha$^{-1}$, having a cost benefit ratio of 1 : 2.02 followed by urdbean - pigeonpea with Rs. 43,011 ha$^{-1}$, with a cost benefit ratio of 1:1.79.

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(Received on 12- 5 - 2001 and revised on 10 - 7 - 2002)

The Andhra Agric. J. 49 (3&4) : 377 - 379, 2002

## Research Note

# Effect of Sulphur Application on Growth and Yield of Sunflower

**Key Words :** Sulphur, Growth and Yield, Sunflower.

Sunflower is an important oilseed crop that can be cultivated through out the year regardless of season. The oilseed crop removes sulphur from the soil in amount comparable to that of phosphorus, and sulphur application increases the seed yield of sunflower. (Das *et al.*, 1994). Sulphur plays an important role in the nutrition of oilseed crops as it is a constituent of sulphur bearing aminoacids like cystene, cystine, and methionine. It is a constituent of vitamins like Biotine and Thiamine. Besides N,P,K sulphur is indispensable for the synthesis of essential oils and further it plays a vital role in chlorophyll formation. Sulphur application increases crop yield by enabling crops to obtain adequate amounts of sulphur needed to produce high yields, superior quality and in the end higher profits.

An experiment was conducted during *rabi* 2000 - 2001 in Agricultural College Farm, Bapatla. On Sandy clayloam soil with pH of 7.5, medium in available nitrogen (313.6 kg ha$^{-1}$) and available potassium (291 kg ha$^{-1}$), low in available phosphorous (16 kg ha$^{-1}$) and available sulphate sulphur (8.6 ppm). The treatments comprises of all combinations of four sulphur level i.e. 0, 30, 60, and 90 kg ha$^{-1}$ and three sources of sulphur i.e. elemental sulphur, gypsum and ammonium sulphate were tested in a Randomized Block Design with factorial concept and replicated three times.

Measured quantity of sulphur was applied as basal as per the treatments through elemental sulphur, gypsum and ammonium sulphate. Elemental sulphur was incorporated into the soil as per the treatments one month before sowing. A recommended dose of phosphorus (60 kg $P_2O_5$ ha$^{-1}$) and potassium (30 kg $K_2O$ ha$^{-1}$) were applied uniformly to all the plots as basal through diammonium phosphate (DAP) and muriate of potash (MOP). Recommended dose of nitrogen (90 kg ha$^{-1}$) was applied in three splits i.e. half as basal, 1/4th at 25 days after sowing (DAS) and the remaining 1/4th at 55 DAS. To compensate the quantity of nitrogen, urea was used in all the plots except for the plots, which received ammonium sulphate. Sowing of sunflower (APSH - 11) seeds was done at a spacing of 60 x 30 cm. The plots were kept weed free and necessary plant protection measures were taken up against pests and diseases.

The results indicate that sulphur levels, sources did not influence the plant height, where as leaf area index (LAI) responded significantly to sulphur levels. Highest LAI (2.17) was recorded with the application of sulphur @ 90 kg ha$^{-1}$ which

Table : Effect of sulphur application on growth, yield attributes and yield of sunflower

| Treatments | Plant height at Physiological maturity (Cm) | Leaf area index 60 DAS | Drymatter accumulation at physiological maturity ($gm^{-2}$) | Head diameter (Cm) | Filled seed weight $head^{-1}$ (g) | 1000- seed weight (g) | Seed yield ($kg\ ha^{-1}$) | Oil yield ($kg\ ha^{-1}$) |
|---|---|---|---|---|---|---|---|---|
| Levels ($kg\ ha^{-1}$) : | | | | | | | | |
| $S_0$ | 167.9 | 1.67 | 585.5 | 15.4 | 45.2 | 49.7 | 1911 | 717 |
| $S_{30}$ | 168.2 | 1.82 | 628.5 | 16.1 | 48.2 | 51.8 | 2174 | 865 |
| $S_{60}$ | 172.3 | 2.01 | 699.9 | 16.9 | 50.5 | 56.2 | 2623 | 1096 |
| $S_{90}$ | 176.3 | 2.17 | 746.3 | 17.2 | 53.7 | 60.4 | 2916 | 1159 |
| C.D (0.05) | NS | 0.31 | 48.2 | 0.9 | 6.3 | 3.7 | 310.0 | 139 |
| Sources : | | | | | | | | |
| Elemental sulphur | 168.7 | 1.81 | 654.9 | 16.2 | 47.6 | 53.5 | 2372 | 938 |
| Gypsum | 170.9 | 1.87 | 666.3 | 16.4 | 48.5 | 54.1 | 2396 | 953 |
| Ammonium sulphate | 173.9 | 2.06 | 673.9 | 16.5 | 50.6 | 56.0 | 2449 | 987 |
| C.D. (0.05) | NS | NS | NS | NS | NS | NS | NS | NS |

was significantly superior to that of no sulphur and $S_{30}$, but remained comparable with that of $S_{60}$. This increase might be attributed to better nutritional environment at the active vegetative growth. The results of the present study are in agreement with that of Intodia and Tomar (1997).

Highest drymatter (746.3 $gm^{-2}$) at physiological maturity was recorded with the application of sulphur @ 90 kg $ha^{-1}$ which was significantly superior to that of no sulphur and $S_{30}$, but remained comparable with that of $S_{60}$ (Table). This increase in drymatter production might be due to improved nutritional environment as a result of increased sulphur supply to favourably influence the carbohydrate metabolism (Yadav and Singh, 1970). Further the increase in drymatter accumulation due to S application in sunflower might also be due to its role in the formation of aminoacids, synthesis of proteins, vitamins and chlorophyll. It had favourable effect on drymatter per plant and yield components due to proper partitioning of photosynthates from source to sink (Legha and Gajendra Giri 1999).

Application of sulphur at higher rates (60 and 90 kg $ha^{-1}$) resulted in increased values of yield attributes viz., head diameter, filled seed weight head $^{-1}$ and 1000 - seed weight (Table 1). Sulphur application @ 90 kg $ha^{-1}$ recorded significantly the highest seed yield and oil yield which were superior to that of lower levels. 0 and 30 kg $ha^{-1}$ but was on a par with that of $S_{60}$.

Seed yield is the function of yield attributing characters i.e., head diameter, weight of filled seeds $head^{-1}$ and test weight. Results of the present investigation indicated that seed yield increased with the application of sulphur, due to increase in yield attributing characters. The profound influence of sulphur fertilization on growth, yield attributes and yield could be attributed to increased metabolic process in plants which seems to have promoted meristematic activities causing higher growth and expansion of photosynthetic surface (Baldev Ram and pareek, 1999). The increase in seed yield due to the effect of sulphur in utilizing larger quantities of nutrients through well developed root system which might have resulted in better plant development and ultimate yield. Cumulative effect of improvement of growth parameters through efficient metabolic activity and increased rate of photosynthesis might have lead to maximum expression of yield attributing characters and hence higher seed yield.

The effect of Sulphur sources was non-significant with all the parameters studied i.e. growth, yield attributes and yield. Hence, in view of cost of sulphur fertilizer, gypsum was the cheapest sulphur fertilizer (Rs 1/ kg) followed by ammonium sulphate and finally elemental sulphur. But among these three sources, elemental sulphur should be applied one month before sowing, otherwise it would not allow sufficient time for oxidation (Jain and Saxena 1989). Finally it can be concluded that the gypsum or ammonium sulphate @ 60 kg $ha^{-1}$ would be ideal for realizing higher yields of sunflower.

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(Received on 28-4-2002 and revised on 4-8-2002)

The Andhra Agric. J. 49 (3&4) : 380 - 381, 2002

# Research Note

# Influence of Nitrogen and Azospirillum on Growth, Yield and N Uptake of Sesame Under Rainfed Conditions

**Key Words :** Nitrogen, Azospirillum, Uptake, Sesame

A field trail was conducted during *kharif* 1996 at Tirupati Campus of S.V. Agricultural College. The experiment was laid out in a split - plot design, replicated thrice. The main - plot treatments consisted of three varieties viz., Madhavi ($V_1$), VR1-1 ($V_2$) and TMV-3 ($V_3$) and sub - plot treatments consisted of six nitrogen levels viz., No nitrogen ($T_1$), Azospirillum at 3 Kg ha$^{-1}$ as soil treatment ($T_2$), recommended dose of fertilizer nitrogen 60 Kg N ha$^{-1}$ ($T_3$). Azospirillum + 50% recommended dose of nitrogen ($T_4$), Azospirillum + 75% recommended dose of nitrogen ($T_5$) and Azospirillum + 100% recommended dose of nitrogen ($T_6$). Azospirillum was applied @ 3 Kg ha$^{-1}$ as soil treatment by placement to all plots. The soil of the experimental site was red sandy loam in texture with pH 6.8 low in organic carbon (0.29%) and available N (138.7 Kg ha$^{-1}$) and medium in P (10.2 Kg ha$^{-1}$) and K (139.7 Kg ha$^{-1}$). The fertilizers were applied by band placement in furrows made with hand hoe at a depth of 5 cm at the time of sowing. Healthy and mature sesame seeds treated with Mancozeb @ 3 gm Kg$^{-1}$ seed). The seeds are mixed with sand in the ratio of 1:3 to facilitate uniform distribution. The spacing adopted in seame is 30 x 10 cm. Need based plant protection measure were adopted. The crop was harvested at physiological maturity. Data on growth, yield and N uptake were recorded from sample plants.

There was significant differences in Sesame varieties and fertilizer combinations with interaction. Among these varieies Madhavi recorded higher plant height with 60 Kg N ha$^{-1}$. This might be due to the difference in genetic make up of the varieties. Such difference in plant height due to varieties were also observed by Rao *et al.* (1990). Taller plants recorded with 60 Kg N ha$^{-1}$ + Azospirillum the reason that nitrogen in combination of Azospirillum could attribute to increased nitrogen fixation and production of growth hormones by bacteria. LAI was maximum with TMV-3 which might be due to production of more number of leaves per plant. Higher dry matter of Madhavi at initial stages and around flowering might have a distinct physiological advantage to get more yield than TMV - 3 and VRI -1 (Table). These results are in accordance with the findings of Ramana (1989). But in leaf number and total drymatter production the interaction effect was not significant.

Yield of crop plants is a complex function of genetic make up, edaphic and climatic factors. Significant differences were observed due to interaction of varieties and fertilizer treatments. Application of 60 Kg N ha$^{-1}$ gave higher seed

Table : Influence of Nitrogen and Azospirillum on growth, yield and N uptake of sesame varieties

| Treatments | Plant height(cm) at 75 DAS | | | Leaf Area Index at 75 DAS | | | Seed yield Kg ha$^{-1}$ | | | N uptake at maturity Kg ha$^{-1}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $V_1$ | $V_2$ | $V_3$ | $V_1$ | $V_2$ | $V_3$ | $V_1$ | $V_2$ | $V_3$ | $V_1$ | $V_2$ | $V_3$ |
| $T_1$ | 69.8 | 67.4 | 68.6 | 3.20 | 3.12 | 3.31 | 103.3 | 100.0 | 103.3 | 29.0 | 30.1 | 29.2 |
| $T_2$ | 70.6 | 67.7 | 68.9 | 3.35 | 3.24 | 3.47 | 123.3 | 115.0 | 115.0 | 29.5 | 30.8 | 30.0 |
| $T_3$ | 83.3 | 79.8 | 82.1 | 4.12 | 3.80 | 4.06 | 400.0 | 266.6 | 346.6 | 47.7 | 49.0 | 47.0 |
| $T_4$ | 82.5 | 76.6 | 79.6 | 3.51 | 3.36 | 3.75 | 375.0 | 240.0 | 330.0 | 42.1 | 46.8 | 44.4 |
| $T_5$ | 83.0 | 78.5 | 81.3 | 3.62 | 3.55 | 3.75 | 390.0 | 258.3 | 342.0 | 44.1 | 46.2 | 45.1 |
| $T_6$ | 84.6 | 80.5 | 82.7 | 4.43 | 3.52 | 4.47 | 327.5 | 210.0 | 285.0 | 49.6 | 51.2 | 50.6 |
| | SEm ± | | CD (0.05) | SEm ± | | CD (0.05) | SEm ± | | CD (0.05) | SEm ± | | CD (0.05) |
| V | 0.11 | | 0.46 | 0.01 | | 0.06 | 1.74 | | 6.81 | 0.12 | | 0.50 |
| T | 0.07 | | 0.21 | 0.02 | | 0.06 | 3.74 | | 10.78 | 0.14 | | 0.42 |
| T at V | 0.12 | | 0.36 | 0.04 | | 0.11 | 6.48 | | 18.68 | 0.25 | | 0.73 |
| V at T | 0.26 | | 0.91 | 0.03 | | 0.12 | 4.70 | | 13.94 | 0.30 | | 0.96 |

yield which was on a par with 45 Kg N ha$^{-1}$ + Azospirillum. The per cent increase in yield was 97.5, 93.7 with 45 Kg N ha$^{-1}$ + Azospirillum, 30 Kg N ha$^{-1}$ + Azospirillum respectively over 60 Kg N ha$^{-1}$. Azospirillum soil application alone resulted negligible increase in yield. These results are in accordance with the finding of Arunachalam and Venkatesan (1984).

Highest total nitrogen uptake at maturity was recorded with VRI - 1 closely followed by TMV - 3 and Madhavi. Application of 60 Kg N ha$^{-1}$ + Azospirillum was comparable with 60 Kg N ha$^{-1}$ alone in nitrogen uptake. Reduced supply of N by 50 per cent has not resulted in reduced uptake of nitrogen where Azospirillum inoculation was done, It may be due to active fixation of atmospheric nitrogen and stimulation of more nitrogen uptake by Azospirillum. Similar findings are reported by Rao *et al.* (1990).

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(Received on 26-9-2001 and revised on 9-12-2001)

The Andhra Agric. J. 49 (3&4) : 382 - 384, 2002

## Research Note

# Efficacy of Different Microbial Insecticides Against *Helicoverpa armigera* (Hubner) On Sunflower

**Key Words :** Efficacy, Microbial Insecticides, *Helicoverpa armigera*, Sunflower

Growing awareness about the ill effects of the pesticides caused wide spread concern among scientists and farmers to opt for new approaches to minimise pest population on the crop plants. In this direction biological control can form one of the economically viable and environmentally compatible and practical pest control components of IPM programme, provided the right organism and methods are employed. One such component is the biological control method involving utilisation of natural enemies such as viruses, bacteria, fungi, protozoa and nematodes. For employing the suitable micro-organisms or pathogens in IPM programme, testing of the same under varied agro-ecological conditions should be initiated. Keeping this in view, present investigation was carried out.

A field experiment was carried out at Main Research Station, UAS, Dharwad, comprised of 7 treatments replicated thrice and randomised. Seeds of BSH - 1 sunflower hybrid treated with ceresan were dibbled in rows spaced at 45 cm apart and 20 cm spacing (on 24-7-99) was maintained between plants. Fertilizer was applied at the rate of 50 : 25 : 25 kg N, N, $P_2O_5$ and $K_2O$ per ha. Ten days after emergence plants were thinned to maintain appropriate plant population. In the vegetative stage in order to avoid leaf eating caterpillar damage spraying was taken with parathion (2%). No other plant protection measure was taken. Different treatments (Table -1) were imposed after anthesis with an interval of 15 days for each spray.

Larval count was taken on 15 randomly selected sunflower heads in each plot. At harvest, per cent head damage and yield / plot were recorded.

The pre-treatment larval count ranged from 10.33 to 12.67 per 15 heads. Pre treatment count of larval population in different plots did not differ significantly. Five days after treatment highest per cent reduction was recorded in recommended package of practice i.e. endosulfan (2ml / L) (50.33%) followed by NPV 250 LE per ha. There is no significant difference among the plots treated with NSKE 5 per cent. *Nomuraea rileyi* 1kg/ per ha, *Bacillus thuringiensis* 1 kg per ha, *Beauveria bassiana* 1 kg / ha, but differed significantly . Even ten days after spraying endosulfan treatment recorded highest per cent reduction in larval population which was followed by NPV. Similar trend was observed even in over all per cent reduction in head damage and increase in Yield. Superiority of endosulfan spay over bio-agents also reported by Bijjur (1990); Arya *et al.* (1996) on sunflower

Table 1: Field efficacy of different microbials against Helicoverpa armigera on sunflower reduction of larval population over control

| Sl.No. Treatments | 1st Application No. of larve | Per cent reduction in larval population | | 2nd Application No. of larve | Per cent reduction in larval population | | 1st Application No. of larve | Per cent reduction in larval population | | 2nd Application No. of larve | Per cent reduction in larval population | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | / 15 heads | 5 Days | 10 DAS | / 15 heads | 5 DAS | 10 DAS | / 15 heads | 5 DAS | 10 DAS | / 15 heads | 5 DAS | 10 DAS |
| 1. *Nomuraea rileyi* (1 kg/ha) | 10.33a | 23.33c<br>(28.85) | 46.29d<br>(42.85) | 5.67c | 37.50d<br>(37.73) | 50.84c<br>(45.46) | 10.33a | 23.84e<br>(29.19) | 46.06c<br>(42.71) | 5.67c | 31.94e<br>(34.38) | 53.24d<br>(46.84) |
| 2. *Bacillus thuringiensis* (1kg/ha) | 11.33a | 21.19c<br>(27.38) | 39.03de<br>(38.63) | 7.00b | 28.81e<br>(32.43) | 48.43c<br>(44.08) | 11.33a | 34.85c<br>(36.16) | 39.05d<br>(38.65) | 7.00b | 35.19d<br>(36.36) | 55.19d<br>(47.96) |
| 3. NPV 250 LE/ha | 11.00a | 30.62b<br>(33.58) | 64.80b<br>(53.60) | 5.67c | 60.37b<br>(50.97) | 72.89b<br>(58.60) | 11.00a | 46.97b<br>(43.25) | 61.03b<br>(51.35) | 5.67c | 53.70b<br>(47.01) | 66.40c<br>(54.55) |
| 4. NSKE (5%) | 11.33a | 23.91c<br>(29.26) | 55.71c<br>(48.26) | 7.33b | 44.32c<br>(41.72) | 73.40b<br>(58.93) | 11.33a | 30.61d<br>(33.55) | 63.73b<br>(53.03) | 7.33b | 40.09c<br>(39.24) | 72.59b<br>(58.64) |
| 5. *Beauveria bassiana* (1 kg /ha) | 12.00a | 16.52d<br>(23.93) | 33.02e<br>(35.02) | 8.00b | 20.83f<br>(27.10) | 32.67d<br>(34.85) | 12.00a | 13.29f<br>(23.77) | 24.85e<br>(29.86) | 8.00b | 22.69f<br>(28.41) | 27.33e<br>(31.48) |
| 6. Recommended practice | 10.67a | 50.33a<br>(45.17) | 82.87a<br>(66.32) | 4.00d | 75.00a<br>(60.27) | 89.32a<br>(71.95) | 10.67a | 62.12a<br>(51.99) | 73.68a<br>(59.13) | 4.00d | 72.69a<br>(58.49) | 94.71a<br>(77.63) |
| 7. Untreated check | 12.67a | 10.30e<br>(18.70) | 20.68f<br>(27.03) | 10.00a | 6.06g<br>(14.24) | 12.12e<br>(20.36) | 1.2.67a | - | - | 10.00a | - | - |
| SEM ± | 0.70 | 0.66 | 1.57 | 0.42 | 1.19 | 1.48 | 0.70 | 0.32 | 0.72 | 0.42 | 0.41 | 1.15 |
| C.D. at (0.05) | NS | 2.05 | 4.84 | 1.30 | 3.68 | 4.58 | NS | 0.96 | 2.18 | 1.30 | 1.25 | 3.47 |
| C.V. (%) | 8.09 | 3.91 | 6.12 | 9.40 | 5.48 | 5.93 | 8.09 | 1.76 | 3.16 | 9.40 | 2.05 | 4.37 |

Figures in parantheses are arcsine transformed values DAS = Days after spray

In a coloumn, mean followed by same alphabet do not differ significantly (p = 0.05) by DMRT

Table 2 : Effect of different microbials on *Helicoverpa armigera* on sunflower (chead damage) and field

| Sl.No. Treatments | Mean per cent head damage | | | Over all | Kernal yield | | |
|---|---|---|---|---|---|---|---|
| | Before application | After first application | After first application | per cent head damage | Kg /plot | Q/ha | C : B ratio |
| 1. Nomuraea rileyi (1 kg/ha) | 24.44a | 33.35cd | 40.02c | 36.68c | 1.16c | 9.67c | 2.93 |
| 2. *Bacillus thuringiensis* (1 kg /ha) | 25.88a | 33.35cd | 42.22bc | 38.88bc | 1.07cd | 8.92d | 1.27 |
| 3. NPV 250 LE/ha | 23.22a | 33.35cd | 33.35d | 31.11d | 1.31b | 10.92b | 3.16 |
| 4. NSJE (5%) | 22.66a | 33.35cd | 35.55d | 33.31d | 1.29b | 10.75b | 3.01 |
| 5. Beauveria bassiana (1 kg/ha) | 22.66a | 33.35cd | 44.42b | 41.08b | 0.98de | 8.17e | 1.05 |
| 6. Recommended practice | 24.08a | 33.35cd | 28.88e | 26.66e | 1.48a | 12.34a | 5.12 |
| 7. Untreated check | 23.10a | 33.35cd | 53.36a | 47.76a | 0.88e | 7.33f | --- |
| SEM ± | 1.584 | 1.03 | 1.09 | 1.14 | 0.04 | 0.20 | |
| C.D. at (0.05) | NS | 3.06 | 3.24 | 3.36 | 0.12 | 0.61 | |
| C.V. (%) | 7.59 | 8.09 | 9.24 | 8.477.59 | 6.20 | 6.27 | |

In a column, means followed by same alphabet do not differ significantly (P = 0.05) by DMRT and Gopali (1998) on pigeon pea. Efficacy on NPV in sunflower against *H. armigera* is in conformity with the results of Rabindra *et al.* (1985) and Bijjur (1990).

Efficacy of NSKE 5 per cent against *H. armigera* in conformity with Thakur *et al.* (1988) and Dubey *et al.* (1991). In present investigation *Nomuraea rileyi* 1 kg ha$^{-1}$ performed better than *B. thuringiensis* is due to high relative humidity during study period and transfer of spores from the adjacent fields where already epizootics were there. Benefit acquired for every rupee investment on the input cost tilted in favour of endosulfan with a return of about Rs. 5.11, followed by NPV (Rs. 3.16), NSKE (Rs. 3.01), N. *rileyi* (Rs. 2.93), *B. thuringiensis* (Rs. 1.27) and *B. bassiana* (Rs. 1.05). Though B. *thuringiensis and B. bassiana* found to be cost effective, but were less remunerative. However, in the relation associated hazards with chemical toxicants, the higher B:C ratio sublime the control advantage. Cumulative effect of these bioagents over years should surpass the B:C ratio of chemical by harnessing complementary effect of biotic pressure on the environment.

## ACKNOWLEDGEMENTS

The author is highly thankful to the Indian Council of Agricultural Research for providing financial support in the form of Junior Research Fellowship.

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(Received on 19-1-2002 and revised on 5-10-2002)

The Andhra Agric. J. 49 (3&4) : 385 - 386, 2002

## Research Note

# Crop Loss Assessment Due to insect pests in Rice

**Key Words :** Crop loss, Assessment, Insect, Rice.

Rice continues to hold the key to sustained food sufficiency in the country as it is contributing consistently around 45 per cent of India's total food grain production. Rice being staple food is grown under widely varying agro-climatic conditions in the country and is prone more frequently to abiotic and biotic stresses causing severe yield reduction. Among the biotic stresses, insect pests alone cause yield losses to an extent of 21-51 per cent in rice (kalode, 1983). After the introduction of high yielding varieties of rice, the losses in yield due to leaf hoppers and plant hoppers between 1969 to 1977 were estimated to be 22.4 per cent and the monetary loss due to rice insect pests in nine major rice growing states was estimated to be 205 crores (Dhaliwal and Arora, 1996). In Andhra Pradesh (A.P.), stem borer, gallmidge, leaf folder, green leaf hopper, brown plant hopper and rice ear head bug are some of the important pests of common occurrence both in *kharif* and *rabi* seasons resulting in heavy yield losses. In addition to the above, thrips, whorl maggot and case worm cause location - specific problems. Hence the insect pests are one of the major constraints to be managed effectively to achieve stable higher rice yields. Keeping the above in view, a field experiment was conducted with an objective to assess the crop loss due to various insect pests which is essential for better understanding and formulating appropriate strategies for their control.

Field investigation was conducted at the experimental fields of rice section, Agricultural Research Institute, Rajendra nagar, Hyderabad (A.P.) during *kharif* and *rabi* seasons of 1998 - 99 to assess the impact of insect pests on the grain yield of rice. The experiment was laid out in a Randomized Block Design with factorial concept, replicated thrice. The treatments comprised of two popular varieties viz., Tellahamsa and Samba Mahsuri in *kharif*, Tellahamsa and IR-64 in *rabi* planted under three staggered plantings with two levels of protection (No protection (NP) and need based protection (P)). Recommended plant protection measures were adopted during the entire period of experimentation in protection plots. Grain yield data was recorded leaving two border rows and the data were subjected to statistical analysis.

Number of insect pests attacked during *kharif* was high which includes thrips,whorl maggot, gall midge, leaf folder and stemborer compared to *rabi* crop attacked by thrips, whorl maggot and stem borer only. The data on the grain yield as influenced by various treatments are given seasonwise (Table 1). Among three

Table : Grain yield (kg ha$^{-1}$) as influenced by different treatments during *kharif* and *rabi* 1998 -99.

| | *kharif* | | | | *rabi* | | | |
|---|---|---|---|---|---|---|---|---|
| | Tellahamsa | | Samba Mahsuri | | Tellahamsa | | IR - 64 | |
| Plantings | P | NP | P | NP | P | NP | P | NP |
| $P_1$ | 5086.5 | 3319.8<br>(34.7) | 5664.5 | 4419.5<br>(21.9) | 9135.8 | 8205.1<br>(10.2) | 9227.9 | 7606.8<br>(17.6) |
| $P_2$ | 3216.1 | 2946.4<br>(8.4) | 5187.5 | 3375.4<br>(34.9) | 9684.9 | 8376.0<br>(13.5) | 10583.9 | 9743.5<br>(7.9) |
| $P_3$ | 2780.3 | 1950.4<br>(29.8) | 2469.1 | 2199.4<br>(10.9) | 10370.3 | 9230.7<br>(10.9) | 10056.9 | 8451.2<br>(15.9) |

| Treatments | Mean | F-Test | SEd ± | C.D. | Mean | F-Test | SEd ± | C.D. |
|---|---|---|---|---|---|---|---|---|
| Variety (V) | | | | | | | | |
| $V_1$ | 3216.1 | ** | 170.9 | 334.9 | 9167.2 | NS | 158.7 | 310.9 |
| $V_2$ | 3885.9 | - | - | - | 9270.3 | | | |
| Plantings (P) | | | | | | | | |
| $P_1$ | 4621.8 | ** | 209.3 | 410.2 | 8543.9 | ** | 194.3 | 380.9 |
| $P_2$ | 3681.3 | | | | 9597.1 | | | |
| $P_3$ | 2349.8 | | | | 9527.3 | | | |
| Protection (Pr) | | | | | | | | |
| NP | 3035.2<br>(25.3) | ** | 170.9 | 334.9 | 8602.2<br>(7.90) | ** | 158.7 | 310.9 |
| P | 4066.9 | | | | 9343.3 | | | |
| Interactions | | | | | | | | |
| V x P | - | * | 295.9 | 580.1 | | ** | 274.8 | 538.6 |
| V x Pr | - | NS | 295.6 | 473.6 | | NS | 274.8 | 439.8 |
| P x Pr | - | NS | 295.9 | 580.1 | | NS | 274.8 | 538.6 |
| V x P x Pr | - | * | 418.5 | 820.4 | | NS | 388.6 | 761.7 |

The figures in the parenthesis are percentage reduction of yield over protection. NS : Non significant

NP : No protection P : Need based protection

* : Significant at 0.05% level; ** : Significant at 0.01% level

plantings, early planted crop recorded significantly higher grain yield (4.6 t ha$^{-1}$) over second planting (3.6 t ha$^{-1}$) and third planting (2.3 t ha$^{-1}$) in *kharif*. In *rabi* season, significantly lower grain yield of 8.5 t ha$^{-1}$ was recorded with first planting compared to second (9.6 t ha$^{-1}$) and third plantings (9.5 t ha$^{-1}$), while second and third planting are on par with each other. In *kharif* need based protection recorded significantly higher grain yield (4.0 t ha$^{-1}$) over no protection (3.0 t ha$^{-1}$) indicating 25.3 per cent reduction in grain yield in no protection plots. Similarly there was significant reduction (7.9%) in grain yield in no protection over need based protection in *rabi* season.

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(Received on 15-1-2001 and revised on 20-11-2001)

The Andhra Agric. J. 49 (3&4) : 387 - 388, 2002

## Research Note

# Efficacy of Eight Different Chemicals Against Ber Fruit Borer, *Meridarchis schyrodes* Meyrick

**Key Words :** Efficacy, Chemicals, Ber Fruit Borer

A field experiment was conducted for about three years from 1998 to find out the effectiveness of eight (8) insecticides in managing the ber fruit borer (*Meridarchis schyrodes* Meyrick) in May pruned crop at Agricultural Research Station, Anantapur. A total of four sprays were given at 20 days interval starting from pea size stage of the fruit. Of the eight chemicals tested, polytrin 0.044% (profenophos 40 % + cypermethrin 4%) showed highest performance against ber fruit borer recording the lowest per cent fruit damage. Monocrotophos 0.03% and Quinalphos 0.07% were the next best treatments. Profenophos, dimethoate and endosulfan were less effective and carbaryl and neem oil suspension were least effective.

Ber (*Zizyphus jujuba*) is an important hardy fruit crop grown in arid and semi arid regions of India. The major ber growig states in our country are Madhya Pradesh, Bihar, Uttar Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Maharastra and Andhra Pradesh. Several insect pests are found to feed on ber, of them fruit fly (*Carpomyia vesuviana*), fruit borer (*Meridarchis schyrodes*), bark eating caterpillar (*Indarbela quadrinotata*), Chafer beetle (*Adoretus sp.*) and hairy caterpillar (*Dasychira mendosa*) cause significant damage (*Pareek and Visalnath*, 1996). *M. schyrodes* is distributed all over the country (Nair, 1986). According to Pareek and Visalnath (1996), fruit borer damages the ber mainly in Southern and Western India. At Anantapur, the peak infestation of ber fruit borer has been observed during the month of October coinciding with peak fruit maturity, resulting in heavy loss of net fruit yield. So, the present experiment is proposed to identify the effective chemicals against this borer.

In the variety 'Gola', the trial was laid out in Randomized Block Design with 9 treatments and 3 replications considering one tree as one replication. Treatments were first imposed when fruits are in pea size stage. In total, 4 sprays all with the same chemical in respective treatments) were given with 20 days interval starting from pea size stage of the fruit. An untreated control was also maintained with three replications. At each harvest 100 fruits were collected randomly (covering four sides of the tree) from each replication and average percentage of borer infested fruits was calculated and the data were analysed statistically.

All the treatments significantly differed from one another in recording the per cent borer damage in all the three years (1998 - 2000). The lowest per cent borer infestation was achieved with the treatment of Polytrin (Profenophos + Cypermethrin) 0.044% recording 10.13, 7.5 and

Table : Efficacy of eight chemicals against ber fruit borer, *M. schyrodes* at Agricultural Research Station, Anantapur

| S.No. | Chemical | Concentration (%) | Mean per cent borer infested fruits | | |
|---|---|---|---|---|---|
| | | | 1998 | 1999 | 2000 |
| 1. | Monocrotophos | 0.03 | 17.76 | 12.16 | 1.11 |
| 2. | Dimethoate | 0.03 | 21.14 | 29.50 | 6.50 |
| 3. | Endosulfan | 0.07 | 23.34 | 19.58 | 7.84 |
| 4. | Quinalphos | 0.07 | 20.91 | 12.75 | 2.50 |
| 5. | Profenophos 40% + cypermethrin 4% (Polytrin) | 0.044 | 10.13 | 7.50 | 0.78 |
| 6. | Profenophos | 0.075 | 19.26 | 26.00 | 8.78 |
| 7. | Carbaryl | 0.2 | 32.15 | 39.50 | 9.94 |
| 8. | Neem oil suspension (1998)/ nimbicidine (1999 & 2000) | 0.5 | 36.77 | 44.15 | 14.00 |
| 9. | Control | | 53.57 | 40.92 | 13.33 |
| | S.Em ± | 0.052 | | | |
| | C.D. (0.05) | 0.10 | | | |

0.78%respectively in three years. The next best treatments to Polytrin were monocrotophos 0.03% and quinalphos 0.07% which recorded 17.76, 12.16 and 1.11% and 20.19, 12.75 and 2.50% borer damage respectively in the three years. Dimethoate 0.03%, endosulfan 0.07% and profenophos 0.08% were showed less performance in reducing the borer infestation (Table). Carbaryl 0.2% and neem oil suspension/ nimbicidine were not at all effective against this borer. Nimbicidine recorded even higher per cent borer damage than control treatment during 1999 and 2000 wherein 44.15% and 14.00% borer infestation was obtained against 39.50% and 13.33% in untreated control respectively in two years. Chemical control studies against ber fruit borer, *M. Schyrodes* conducted at Rahuri and Anantapur since 1987 showed that chemicals such as : monocrotophos 0.08%, fenvalerate 0.01%, carbaryl 0.2%, deltamethrin 0.01% and quinalphos 0.05% were effective (Pareek and Visalnath, 1996). So the present findings are in accordance with this results except in case of carbaryl. The good response of polytrin could be attributed to its characteristic features like insecticidal activity over an extended period which helps in managing the overlapping generations, effectiveness against egg, larval and adult stages of insects, antifeedent and repellent action and lipophilic properties which does not allow the chemical to readily wash off to the rain. While monocrotophos has both systemic and contact action and quinalphos has good penetrating power in addition to contact action.

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(Received on 20-7-2001 and revised on 30-11-2001)

The Andhra Agric. J. 49 (3&4) : 389 - 391, 2002

## Research Note

# Nutrient Uptake and Quality Aspect of Soybean as influenced by Sowing Dates and N-P Fertilizer levels

**Key words :** Nutrient Uptake, Soybean Sowing Dates

An experiment was conducted during *rabi* 1997 - 98 at Agricultural College farm, Bapatla to study the effect of five sowing dates (Viz : 17th October, 1st November, 16th November, 1st December and 16th December) and four levels of N-P fertilizers ($N_0P_0$, $N_{40}P_{40}$, $N_{80}P_{80}$, and $N_{120}P_{120}$) on yield, nutrient uptake, protein and oil contents of soybean in a split plot design replicated thrice. Sowing dates were the main plots and N-p fertilizer levels were sub-plots. The soil of the experimental field was loamy sand having the $p^H$ 7.9 with low in available Nitrogen (251 kg $ha^{-1}$), medium in available Phosphorus (948 kg $ha^{-1}$) and high in available Potassium (672 kg $ha^{-1}$). A uniform dose of 40 kg $K_2O$ $ha^{-1}$ along with 50 per cent nitrogen and entire Phosphorus as per the treatments was applied at the time of sowing. The remaining 50 per cent nitrogen was top dressed at 30 days after sowing as per the treatments. Seeds were spaced at 30 x 10 cm. Irrigations were scheduled on need base. Representative samples of the seed and haulm at harvest from different treatments were analysed separately for N,P and K (Jackson, 1973) and the uptake of these nutrients was calculated by multiplying the concentration of N,P and K with seed and haulm of soybean in different treatments. The Protein content in seed was calculated by multiplying the nitrogen content in seed with the factor 6.25 (AOAC, 1960). The oil content in seed was estimated by nuclear magnetic resonance (NMR) method.

The data on seed and haulm yields (Table 1) indicated that the early sowing (17th October) recorded significantly higher seed and haulm yields than the delayed sowings (Nov & Dec). In early sowings, the higher temperature prevailed during early growth phase might have influenced the physiological activities of plants which in turn enhanced the seed and haulm yields. A linear decrease in seed yield with delay in sowing at 15 days interval from 17th Oct to 30th Nov were also reported by Ojha *et al* (1981) and Pramila Rani (1997). Seed and haulm yield were significantly increased with every increment in N-P fertilization up to $N_{80}P_{80}$ and there after there was only marginal increase. Higher seed yields of soybean with 60 kg N + 80 kg $P_2O_5$ $ha^{-1}$ were also reported by Turkhede *et al*, (1991). However, the Interaction between sowing dates and N-P fertilization was found to be Non - significant.

The total nitrogen, phosphorus and potash uptake were significantly influenced both by sowing dates, N-P fertilization and their

Table : Nutrient uptake, protein and oil content of soybean as influenced by sowing dates And N-P Fertilisation

| Treatment | Seed Yield (t ha$^{-1}$) | haulm Yield (t ha$^{-1}$) | Total nutrient uptake (kg ha$^{-1}$) | | | Protein Content (%) | Oil Content (%) |
|---|---|---|---|---|---|---|---|
| | | | N | P | K | | |
| Sowing Dates | | | | | | | |
| Oct. 17 | 1.81 | 2.41 | 139.8 | 18.99 | 51.49 | 39.39 | 25.98 |
| Nov. 1 | 1.46 | 2.11 | 105.0 | 17.61 | 48.74 | 37.54 | 25.88 |
| Nov. 16 | 1.15 | 1.79 | 80.6 | 15.98 | 45.41 | 36.47 | 25.87 |
| Dec. 1 | 0.91 | 1.51 | 61.6 | 14.02 | 42.40 | 35.66 | 24.72 |
| Dec. 16 | 0.84 | 1.48 | 55.4 | 12.35 | 38.43 | 34.98 | 24.54 |
| CD (P = 0.05) | 0.12 | 0.18 | 7.6 | 1.30 | 1.30 | 0.48 | 0.69 |
| N-P Levels (kg ha$^{-1}$) | | | | | | | |
| $N_0P_0$ | 0.91 | 1.59 | 58.3 | 9.79 | 35.56 | 34.62 | 25.35 |
| $N_{40}P_{40}$ | 1.16 | 1.77 | 80.6 | 12.40 | 41.64 | 36.47 | 25.45 |
| $N_{80}P_{80}$ | 1.40 | 2.03 | 105.8 | 19.77 | 50.17 | 37.98 | 25.63 |
| $N_{120}P_{120}$ | 1.46 | 2.05 | 108.5 | 21.22 | 53.81 | 38.18 | 25.58 |
| CD (P = 0.05) | 0.10 | 0.13 | 6.7 | 0.94 | 1.17 | 0.46 | NS |
| Interaction (D x F) | NS | NS | sig | sig | sig | NS | NS |
| C.V.(%) | 10.80 | 9.72 | 10.2 | 8.01 | 3.47 | 1.69 | 3.59 |

interaction. Crops sown on 17th Oct removed significantly more amount of N,P and K, however, displayed a declining trend in the nutrient uptake of N,P and K when the sowings were delayed from 1st Nov to 16th Dec. The favourable temperatures and bright Sun shine hours during the vegetative phase of soybean might have facilitated increased assimilation of dry matter and seed yield. Application of $N_{80}$ $P_{80}$ displayed superior performance in nutrient uptake compared to the remaining levels. Similar results were also reported by Jat and Nepalia (1994). Early sowing coupled with higher fertilizer levels resulted in increased nutrient uptake and greater seed yield. However, the optimum N-P fertilizer dose was found to be 80 kg N and 80 kg $P_2O_5$ ha$^{-1}$.

Nitrogen, Phosphorus and Potassium nutrient uptake were significantly influenced by sowing dates x N-P levels. Early sowing (17th Oct) in combination with $N_{120}P_{120}$ levels recorded the highest N,P and K uptake, which was linear with $N_{80}P_{80}$.

Protein content was significantly influenced by sowing dates and N-P fertilizer levels but their interaction were non-significant. The first date of sowing recorded significantly the highest protein content, while significant decrease was associated with each delayed sowing. The highest protein content as recorded with $N_{120}P_{120}$, which was at par with the combination of $N_{80}P_{80}$. However, the protein content increased significantly from $N_0P_0$ to $N_{80}P_{80}$.

The oil content was significantly influenced only by dates of sowing. The maximum oil content (26%) was obtained with 1st Nov and 16th Nov sowings. But, all these three dates of sowing were found to be superior to the other two dates.

Neither the fertilizer levels nor the interaction between sowing dates and fertilizer levels had a significant effect on oil content.

Thus, the present investigation indicates that seed yield, nutrient uptake, protein and oil content were the highest when resorted to early sowing (17th Oct) coupled with optimum fertilizer dose of 80 kg N + 80 kg $P_2O_5$ $ha^{-1}$.

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(Received on 27-11-2000 and revised on 20-10-2001)

The Andhra Agric. J. 49 (3&4) : 392 - 393, 2002

## Research Note

# Effect of Moisture Stress on Pigeonpea Under Block Cotton Soils of Krishna - Godavari Zone

**Key Words :** Moisture Stress, Pigeonpea Block Cotton Soils, Krishna Godavari Zone.

Generally, the Pigeonpea crop grown during *kharif* and early *rabi* season, often face the high moisture stress at seedling stage as it receives heavy rainfall due to cyclonic rains in the months of September and October, which results in high mortality of seedlings, poor crop stand and ultimately results in lower seed yields. Either drought or excessive moisture causes imbalance of various metabolic activities which inturn cause set back in the growth and development of plant. Hence, the present study was proposed to screen the suitable genotypes for drought or excessive moisture under natural conditions in block cotton soils of Krishna, Godavari Zone.

An experiment was conducted at Regional Agricultural Research Station, Lam, Guntur during *kharif*, 1998 in block cotton soils. The experiment was laidout in Randomised Block Design, replicated thrice in a plot size of 9m x 5m, adopting a spacing of 90cm x 20 cm. The treatments consists of 10 varieties i.e., ICPL 94062, ICPL 87119, ICPL 131, ICPL 94063, ICPL 85063, ICP 8863, ICPL 88047, ICPL 332, ICPL 87051 and LRG 30 (Check). The recommended dose of fertilizers and timely plant protection measures were taken as and when required. The sowing was done on 10-7-98. The data on growth, yield and yield components were recorded.

There was a heavy rainfall of 920 mm received in 45 rainy days from 20-7-98 to 13-11-98, the experimental plots were severely affected by excessive soil moisture. The mortality percentage was more in ICCPL 332 (24.1) followed by ICPL 88047 (6.9) (Table). No rainy day was recorded from 14th November 1998 to maturity. There was significant differences between genotypes for growth and yield components.

Among 10 genotypes tested, the genotype LRG 30 (Check) recorded the maximum plant height (242.3cm) and total dry matter (17.6 g plant$^{-1}$). The lowest dry matter recorded in ICPL 87051 (11.0 g plant$^{-1}$) followed by ICPL 332 (12.1 g). The highest relative water content was recorded in LRG 30 (82.5%) followed by ICPL 85063 (78.3%) and ICPL 332 (78.1%), which indicates better tolerance to moisture stress and maintained better growth. The genotypes showed significant differences in yield and yield components. The number of pods/plant was highest in LRG 30 (142.6) followed by ICPL 85063 (112.4) and ICPL 332 (104.0). There was no significant difference in number of seeds/pod. The harvest index was more in LRG 30 (43.3) followed by ICPL 332 (42.0) and ICPL 85063

Table : Evaluation of Pigeonpea genotypes for mosture stress / excessive moisture under natural conditions

| Variety | Plant height (cm) | No. of branches | Days to 50% flowering | Days to maturity | Dry matter production (g /pl) | Mortality due to excess moisture | No.of pods per plants | No. of seeds per pod | Test wt. (100 seed wt (g)) | Seed yield q ha$^{-1}$ | Harvest index | RWC (%) during drought |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LRG 30 | 243.3 | 10.2 | 128 | 196 | 17.6 | 1.77 | 142.6 | 4.13 | 9.07 | 19.80 | 43.3 | 82.5 |
| ICPL 94062 | 222.7 | 10.7 | 122 | 186 | 15.4 | 1.60 | 62.9 | 4.23 | 10.62 | 12.66 | 28.9 | 73.5 |
| ICPL 87119 | 225.3 | 8.5 | 124 | 194 | 15.6 | 1.00 | 69.1 | 4.01 | 13.05 | 13.85 | 31.10 | 76.10 |
| ICPL 131 | 239.7 | 6.4 | 130 | 194 | 14.3 | 3.20 | 68.5 | 4.33 | 10.62 | 13.51 | 30.50 | 76.30 |
| ICPL 94063 | 207.7 | 10.9 | 124 | 184 | 14.2 | 2.03 | 98.5 | 4.27 | 11.07 | 13.17 | 30.10 | 76.30 |
| ICPL 85063 | 220.0 | 11.1 | 128 | 196 | 14.2 | 1.77 | 112.4 | 4.03 | 10.75 | 18.16 | 41.8 | 78.30 |
| ICPL 8863 | 186.7 | 7.5 | 130 | 193 | 12.9 | 3.13 | 71.8 | 4.10 | 10.89 | 13.10 | 34.5 | 74.90 |
| ICPL 88047 | 171.3 | 7.6 | 125 | 193 | 12.9 | 6.90 | 88.8 | 4.00 | 9.97 | 13.74 | 35.0 | 76.00 |
| ICPL 332 | 151.3 | 8.1 | 127 | 195 | 12.1 | 24.07 | 104.00 | 4.03 | 9.75 | 17.87 | 42.00 | 78.10 |
| ICPL 87051 | 141.3 | 8.0 | 124 | 185 | 11.0 | 4.78 | 68.3 | 4.23 | 10.89 | 12.01 | 26.00 | 72.40 |
| CD (0.05) | 18.3 | 0.61 | NS | 6.11 | 1.26 | -- | 12.7 | NS | 0.53 | 1.85 | 1.38 | -- |
| CV % | 5.25 | 4.01 | 2.12 | 1.85 | 5.24 | - | 8.39 | 8.10 | 2.85 | 7.30 | 8.26 | -- |

(41.8). Maximum seed yield was recorded in LRG 30 (19.80 q ha$^{-1}$) followed by ICPL 85063 (18.16 q ha$^{-1}$) and ICPL 332 (17.87 q ha$^{-1}$) which may be due to high relative water content, number of pods/plant and high harvest index. Similar findings were reported by Jirali *et al.* (1994) in chickpea. Further it can be concluded that LRG 30, ICPL 85063 and ICPL 332 were found to be suitable for rainfed conditions in block cotton soils of Krishna Godavari Zone of Andhra Pradesh.

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(Received on 31-12-2001 and revised on 9-8-2002)

The Andhra Agric. J. 49 (3&4) : 394 - 396, 2002

# Research Note

# Estimation of Drainage Coefficient from Rainfall DATA

**Key Words :** Drainage Coefficient, Rainfall

Rainfall plays predominant role in many of the agricultural operations. The occurrence or non-occurrence of rainfall at decisive times can resolute the accomplishment or miscarriage of a venture in agricultural production, gemination of seeds, drying of crops, application of irrigation and fertilizers etc. Rainfall forecasting is the prominent aspect of hydrologic investigation. Since the rainfall distribution is a function of time, it is necessary here to investigate the rainfall data with regard to plotting position which gives anticipated magnitude of occurrence of rainfall at a given probability for any specific period.

Drainage coefficient is defined as the depth of water in millimeters to be drained off from a given area in 24 hours of duration. In this study the parameter is calculated from rainfall depth - duration - frequency curves plotted with time duration values on abscissa and rainfall values as ordinate. The drainage coefficient are thus found by drawing tangents from the point representing 75 mm rainfall on ordinate to various duration curves. The slopes of the tangent lines drawn to the curves indicate respective drainage coefficients.

The rainfall data of Samalkot region of Andhra Pradesh available for the past 20 years (1977 - 1996) is analyzed by the most widely accepted method, Weibull's formula. The plotting position is calculated after arranging the data in descending order of their magnitude and ranking it (Battachary and Sankar, 1981)

$$F_a = \frac{m}{N+1} \times 100$$

Where Fa = Plotting position for m$^{th}$ ordered observation expressed in percentage.

m = Order of the observations arranged in the descending magnitude.

N = Sample size.

The return period or recurrence interval is calculated by the expression

$$\text{Return period} = \frac{1}{\text{Plotting position}} = \frac{N+1}{m}$$

Rainfall probability analysis is performed by plotting the magnitude of an event against its probability of occurrence on arithmetic probability paper. The rainfall data is transformed to **CUBE ROOT** data to get linearity over a wide mid-range of plotted data. The weekly and monthly rainfall magnitudes are forecasted at 20, 40, 60, and 80% probability levels for 5, 10 and 20 year return periods.

The data forecasted from the analysis is utilized for developing the rainfall depth duration

Table 1: Monthly rainfall at different probability levels and return Periods

| Month | Rainfall (mm) at probability levels indicated | | | | Rainfall (mm) for different return periods (Years) | | |
|---|---|---|---|---|---|---|---|
| | 20% | 40% | 60% | 80% | 2 | 5 | 10 |
| January | 92.35 | 46.66 | 20.12 | 5.00 | 31.3 | 92.4 | 148.9 |
| February | 85.18 | 44.74 | 19.68 | 5.83 | 31.3 | 85.2 | 125.0 |
| March | 48.63 | 25.67 | 12.49 | 4.09 | 17.6 | 48.6 | 71.5 |
| April | 48.63 | 29.79 | 15.63 | 6.03 | 21.9 | 49.3 | 74.1 |
| May | 49.34 | 85.18 | 42.88 | 15.25 | 59.3 | 142.2 | 227.0 |
| June | 142.24 | 132.65 | 100.54 | 73.94 | 117.6 | 175.6 | 216.0 |
| July | 175.62 | 164.57 | 117.65 | 82.31 | 140.6 | 216.0 | 274.6 |
| August | 216.00 | 174.68 | 148.88 | 119.09 | 157.5 | 205.4 | 238.3 |
| September | 205.40 | 170.95 | 142.24 | 110.59 | 157.5 | 205.4 | 238.3 |
| October | 300.76 | 185.93 | 117.64 | 64.00 | 157.5 | 300.8 | 389.0 |
| November | 185.19 | 94.19 | 37.59 | 8.00 | 59.3 | 185.2 | 314.4 |
| December | 35.94 | 19.68 | 10.65 | 3.36 | 13.3 | 35.9 | 54.9 |

- frequency curves, which in turn are used for estimating drainage coefficient (Oosterbaan, 1994). In the analysis, it is found that the heaviest storms occur during the month of October, Hence, daily rainfall data of the October month is studied for drainage design. The rainfall for different duration viz., 1,2,3,4,5,6,7 days is estimated by using the maximum total technique.

## Monthly Rainfall Analyiss

The monthly available data of rainfall after being analyzed at 20,40,60 and 80% probability levels for different return periods (Table1), is plotted with estimated rainfall values on ordinate and months as abscissa. The rainfall at 20% probability is found to be as high as 300.00 mm in the month of October. At all probability levels, the rainfall is found to be low from December to March with the lowest values in the month of March.

## Surface Drainage coefficient

Since it is observed that heaviest storms occur in the month of October for the given location, the rainfall of the same month is analyzed for planning the Drainage system. The parameters like amount of rain water standing in the fields and the rate at which it has to be drained off have been determined from the rainfall depth - duration - frequency curves.

The depth of rainfall expected for 5, 10 and 20 years of return periods are estimated in the analysis (Table 2). It is established that paddy crop can tolerate maximum 75 cm standing water that too only for shorter periods. Alarmingly it has been observed that there is the possibility of rainwater standing more than 75 mm depth in the fields for the present case of study, during paddy growing season from August to October and this is a point of concern. Hence a Surface

Table 2 : Depth of rainfall (mm) in different durations and return periods for the month of October

| Duration in Days | Depth of Rainfall (mm) at Return Periods (years) indicated 5 | 10 | 20 |
|---|---|---|---|
| 1 | 92.00 | 115.29 | 130.00 |
| 2 | 114.57 | 136.77 | 181.71 |
| 3 | 131.24 | 159.86 | 197.15 |
| 4 | 151.28 | 183.43 | 247.75 |
| 5 | 166.67 | 189.86 | 259.09 |
| 6 | 174.76 | 195.89 | 271.20 |
| 7 | 177.36 | 209.87 | 274.03 |

drainage system is recommended to remove excess water in the fields to avert any fruther damage to crop. From the cut-off point representing 75mm rainfall on the ordinate, tangents are drawn touching different duration frequency curves. The respective drainage co-efficient represented by slopes of tangents for 5 year, 10 year and 20 year return periods have been estimated as 25.7, 51.0, and 72.0 mm/day respectively.

From the analysis of 20 years Rainfall data of Samalkot Region in Andhra Pradesh, it can be concluded that

It has been observed that the heaviest storms occur in the month of October. Hence rainfall values of October month are analyzed.

It has been noticed that rain water of more than 75mm depth (The tolerance value for paddy crop) stands in the fields during most of the paddy growing season.

The drainage coefficient values have been estimated to be 25.7, 51.0 and 72.0 mm/day for 5,10 and 20 years return periods respectively.

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(Received on 12-7-2000 and revised on 23-9-2002)

The Andhra Agric. J. 49 (3&4) : 397 - 398, 2002

# Research Note

# Effect of Subsurface Drainage System on Crop Yields in Waterlogged and Salt Affected Soils

**Key Words :** Subsurface Drainage System, Crop Yields in Waterlogged, Salt affected soils

Major and medium irrigation projects have been given higher priority all over the world to provide water for irrigation to arid and semiarid areas to increase and to stabilize agricultural production. Faulty on-farm management of irrigation water particularly in the absence of suitable drainage has created problems like waterlogging and secondary salinization. Problematic areas in the command area are increasing gradually. The development of twin problems of waterlogging and soil salinity can be gauged by the reduction in crop yields and cropping intensity. The waterlogged area in Karnataka varies from 0.1 to 0.389 lakh ha, and the extent of salt - affected areas varies from 0.52 to 4.04 lakh ha (Balakrishnan and Patil, 1998). The area affected by waterlogging and salinity in the Upper Krishna Project (UKP) Command area, under which the present study area falls is about 9000 ha (Balakrishnan and Patil, 1998). A study was carried out in the Upper Krishna Command Area, Karnataka to access the performance of subsurface drainage system on crop yields. In order to combat the problems of waterlogging and soil salinity in NLBC Command two pilot areas namely phase-I and phase-II are selected and subsurface drainage system are installed in 14.7 and 14.4 ha respectively.

Carter (1987) found that the sugar yields increased from 339 to 791 kg ha$^{-1}$ after one year of installation of drainage systems. Similarly Wang *et al.* (1987) found that the ratoon cane growth increased by 27 and 144 per cent at first and second ratoon harvests respectively due to the installation of drains. The presence of system resulted in reducing the soil salinity from 11 dS/m to 2.25 dS/m and increasing yield of rice, sugarcane and betel vine by 15-25, 15-20 and 30-40 per cent respectively, (Ramesh Chandra and Shyam Sunder, 2000.)

The study area falls under the command of Narayanpur Left Bank Canal (NLBC) of the Upper Krishna Project (UKP). The study area is located in between 16°28'1" - 16°30'0" N latitude and 76°27'19" - 76°30'25" E longitude. According to USDA classification, the soils are grouped under Typic Pellusterts (under Vertisols) and belong to Kagalgomb series. The soils come under deep black cotton soils with 44 - 77 per cent of clay. Out of 14.4 ha of study area, 50 m spaced drains are installed in 12.7 ha and in the remaining 1.7 ha area four drains with 30 m spacing were installed.

The crop cutting experiments were conducted in 5x4 m$^2$ area plots in case of cotton and other wide spacing crops and in 2 x 2 m$^2$ area plots in case of paddy crop. The yield of the crop in the above mentioned plots was measured and was later converted to yield per hectare. Similarly, the changes in the cropping are also monitored.

Table : 1 Average Crop yields (q/ha) before and after installation of Subsurface Drainage

| Crop | Pre-drainage* | Post-drainage | Per cent Increase |
|---|---|---|---|
| Cotton | 6.7 | 10.4 | 55.2 |
| Wheat | 2.5 | 10.0 | 300.0 |
| Paddy | 22.8 | 40.0 | 75.4 |
| *Rabi* sorghum | 6.0 | 8.4 | 40.0 |

Table 2: Cropping intensity (per cent) in the study area

| Season | Pre - drainage* | Post - drainage | Per cent Increase |
|---|---|---|---|
| *Kharif* | 44.09 | 76.6 | 73.7 |
| *Rabi* | 54.20 | 79.6 | 46.8 |
| Annual | 98.29 | 156.2 | 58.9 |

(* Source: Balakrishnan and Patil, 1998)

The crop yield data during kharif and rabi / summer seasons were collected and compared with those of pre-drainage data and the results are presented in Table 1. It is evident from the table that there was considerable increase in the yields of crops in the drained areas. The increase in yields due to installation of sub-surface drainage systems in case of cotton, wheat, paddy and *rabi* sorghum was observed to be 55.2, 300, 75.4 and 40.0 per cent respectively.

The pre and post - drainage cropping intensities are shown in Table 2. The cropping intensities during *kharif* and *rabi* seasons are observed to be increased by 73.7 and 46.8 per cent respectively due to the positive influences of subsurface drainage systems. The increase in the annual cropping intensity found to be 58.9 per cent.

## ACKNOWLEDGEMENT

The authors gratefully acknowledge the support received from the Indo-Dutch Net work Project, Bheemerayanagudi, Gulbarga district for carrying out the above study.

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(Received on 20-4-2002 and revised on 11-6-2002)

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## THE ANDHRA AGRICULTURAL JOURNAL

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|---|---|---|
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| Nationality | : | INDIAN |
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| Publisher's Name | : | **Dr. P. VENKATA RAMAIAH**<br>Professor and Univ.Head, Dept. of Agril. Extension<br>Agricultural College, BAPATLA 522 101 (AP) |
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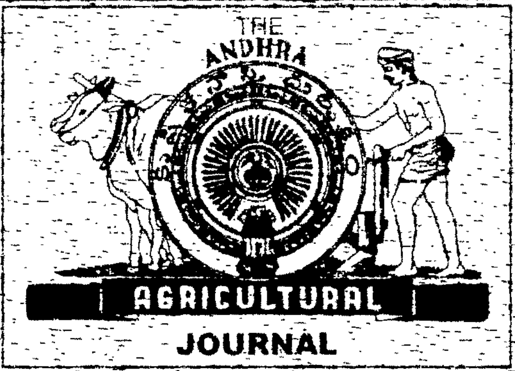
Edited and Published by **Dr. P. Venkata Ramaiah** for The Andhra Agricultural Union
and Printed by **Sri G. Veeraiah** at **Sree Lakshmi Press, Bapatla** - 522 101 (AP)
(Released in December, 2002)

The Andhra Agric. J., 50 (3&4) : 188 - 393, 2004

ISSN 0003-2950



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# THE ANDHRA AGRICULTURAL UNION

(Registered under Act XXI of 1860)

The Andhra Agricultural Journal was started in 1954 as Bimonthly and converted to Quarterly from 1982 onwards and registered with the Registrar of News Paper of India as Quarterly under The Press and Registration of Books Act, 1867 with Registration No. 5751 / 57.

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**Volume 50** **July - December, 2003** **Numbers (3 &4)**

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# GOLDEN JUBILEE CELEBRATIONS OF THE ANDHRA AGRICULTURAL UNION / THE ANDHRA AGRICULTURAL JOURNAL (1954 - 2004)

# NATIONAL SEMINAR ON "RESOURCE MANAGEMENT FOR SUSTAINABLE AGRICULTURE"

## 28 - 30, JANUARY, 2004

## A REPORT WITH RECOMMENDATIONS

The Andhra Agricultural Union with its official organ, The Andhra Agricultural Journal was established in 1954 and thus entered The Golden Jubilee Year in 2004. In commemoration of the Golden Jubilee a three day National Seminar on "Resource Management for Sustainable Agriculture" was conducted from 28th to 30th January, 2004 in Dr. B.V.Nath Auditorium at Agricultural College, Bapatla. The inaugural session on the F.N. of 28-1-2004 was presided by Sri. S. P. Singh, Secretary, Agriculture and Cooperation, Government of Andhra Pradesh & Vice-Chancellor i/c., ANGRAU with his presidential address. Dr. S. Raghu Vardhan Reddy, Registrar & Dean of Agriculture i/c., ANGRAU welcomed the participants. Sri Vadde Sobhanadreswara Rao, Honourable Minister for Agriculture, Government of Andhra Pradesh graced the occassion as Chief Guest and released the Proceedings of the National Seminar as the Golden Jubilee Special Issue of the Andhra Agriculture Journal and delivered the inaugural address. The keynote address was delivered by Padmasree Dr. I. V. Subba Rao, former Vice-Chancellor of ANGRAU. Dr. G. Lakshmi Kantha Reddy, Associate Dean & President (Ex-officio) of the Andhra Agriculture Union presented vote of thanks at the conclusion of the inaugural session. Dr. P. Arujuna Rao., Professor & Head, Deaprtment of Entomology, Agricultural College, Bapatla & Editor of the Andhra Agricultural Journal was the organizing secretary for the National Seminar.

A total of 175 papers were presented in the National Seminar as lead papers followed by oral and poster presentions under the following seven technical sessions.

| S.No. | Technical Session | No. of Papers Presented | | | |
|---|---|---|---|---|---|
| | | Lead Papers | Oral Presentation | Poster Presentation | Total |
| 1. | Soil and Water Management | 1 | 13 | 4 | 18 |
| 2. | Farm Mechanization in Modern Agriculture | 1 | 1 | 1 | 3 |
| 3. | Integrated Nutrient Management | 1 | 12 | 39 | 52 |
| 4. | Implications of WTO on Indian Agriculture | 1 | 4 | 2 | 7 |
| 5. | Integrated Pest / Disease / Weed Management | 1 | 16 | 35 | 52 |
| 6. | Biodiversity | 1 | 12 | 19 | 32 |
| 7. | Post - harvest Handling, Food Processing and Nutritional Security | 1 | 5 | 5 | 11 |
| | Total : | 7 | 63 | 105 | 175 |

Under each technical session one lead paper was presented first by an invited and reputed scientist in the field and it was followed by the oral presentations. Simultaneously posters were also displayed at the places provided under the poster session. A total of 150 delegates representing the entire country have attended the seminar for the presentation of the papers. A special Proceedings of the National Seminar was brought out containing all the papers and was released on the inaugural day i.e. on the F.N. of 28th January, 2004. The copies of the proceedings were distributed to all the delegates. Under each session one best paper and second best paper were selected both under the oral and poster presentations and a merit certificate with a momento was presented to the scientsts concerned.

The important conclusions made in the deliberations of the National Seminar are furnished technical sessionwise below.

## TECHNICAL SESSION - I : Soil and Water Management

A total of 14 papers were presented under the oral session including the lead paper and four papers were dispayed under poster session

The broad areas covered were

i. Soil and water management for sustainable agriculture

ii. Estimation of crop water requirements

iii. Micro-irrigation for limited water management

iv. Soil conservation and watershed management

v. Subsurface drainage and reclamation of degraded lands reducing water logging

vi. Effect of tillage and mulching on water requirement

vii. Skimming well techniques for harnessing fresh water in coastal region

**Salient Findings :**

The land and water resources are playing a significant role to enhance the production and productivity of crops depending upon the fertility status and management practices. The two resources are now dwindling at alarming rates due to ever increasing population. Now the main concern to the scientists and planners is to preserve, conserve and protect these valuable resources as land area cannot be increased but the productivity can be increased by applying the capital - intensive techniques.

Water is one of the most crucial inputs for increasing the agricultural production. In many canal command areas, water is being wasted and discrepancies between head and tailend regions exist and cause overuse and underuse of water. Water management studies show that farmers are using more water than the requirement of a crop, thus wasting so much of precious water resources. Low irrigation efficiencies are also due to improper land preparation, lack of on-farm water management and faulty irrigation techniques. Large areas are experiencing water logging conditions because of raising water table. Soil salinity built up in the top layers of root zone is also due to high water conditions. Soil salinity and water logging demands subsurface drainage for the reclamation of the degraded lands. Proper tillage practices, mulching and soil conservation measures help in conserving the soil moisture and reducing soil erosion in watersheds. Farmers are applying 75% excess quantity of canal water in paddy fields. The excess water application did not increase yield. Instead, it has lead to wastage of valuable water resources.

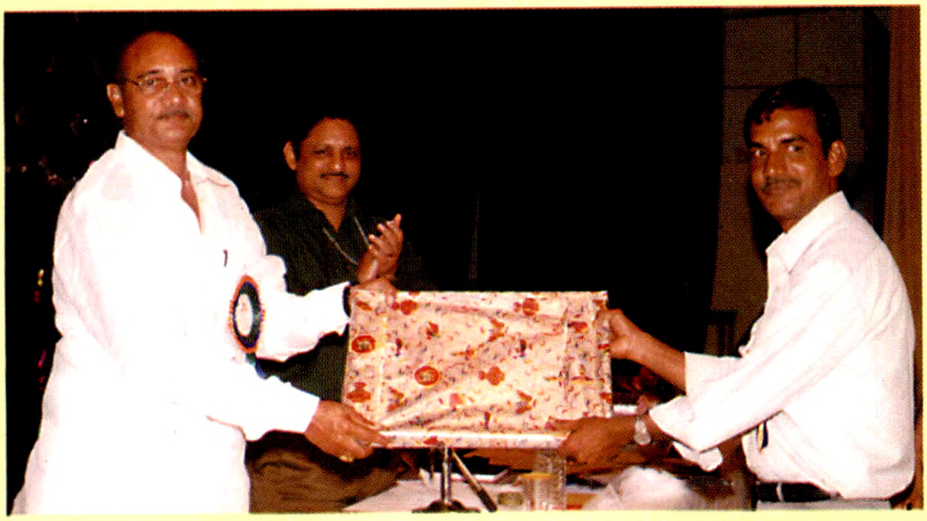
# THE ANDHRA AGRICULTURAL UNION / THE ANDHRA AGRICULTURAL JOURNAL (1954 - 2004)

## GOLDEN JUBILEE CELEBRATIONS - NATIONAL SEMINAR ON "RESOURCE MANAGEMENT FOR SUSTAINABLE AGRICULTURE"

## 28 - 30, JANUARY, 2004

## GLIMPSES OF INAUGURAL & VALEDICTORY FUNCTIONS

Releasing The Proceedings of National Seminar as Golden Jubilee Special Issue - **50** (Spl.) of AAJ. Left to Right - Dr. P. Arjuna Rao - Organizing Secretary, Dr. G. Lakshmi Kantha Reddy - President (Ex-Officio), Padmasree Dr. I.V. Subba Rao - Guest of Honour, Chief Guest - Sri. Vadde Sobhanadreswara Rao, Hon'ble Minister for Agriculture, Presided over by - Sri. S.P. Singh, Secretary, Agriculture & Cooperation & Vice-Chancellor i/c and Dr. S.Raghu Vardhan Reddy, Registrar & Dean of Agriculture i/c, ANGRAU, Hyderabad.



Dr. G. Lakshmi Kantha Reddy, Assoc. Dean and President (Ex-Officio), A.A.U. receiving a Memento from Sri. Vadde Sobhanadreswara Rao, Hon'ble Minister for Agriculture, Govt. of A.P.

Sitting - Left to Right - Dr. S.M. Shareef, Dr. R. Veeraraghavaiah (Vice-President), Dr. G.L.K. Reddy (President), Dr. P. Arjuna Rao (Editor), Dr. B. Venkateswarlu (Secretary) and Dr. P. Raja Sekhar (Treasurer)

Standing - Left to Right - Dr. B.V.S. Prasad, Dr. P.V.N. Prasad, Mr. J.V. Ramana, Dr. G.L.N. Reddy, Dr. G. Ramachandra Rao, Dr. A. Ravi Kumar, Dr. P.R.K. Prasad and Dr. J. Lakshmi

Dr. P. Arjuna Rao, Prof. & Head, Dept. of Entomology and Organizing Secretary receiving a Memento from Dr. B. Rosaiah, Associate Director of Research, RARS, Lam, Guntur

**Salient Recommendations :**

1. Agriculture is the major user of water resource potential created and consumes about 85% of the total water. It is estimated that there will be a cut of 10% from the present allocation in the next 7-8 years, to meet ever increasing demand from the domestic and industrial sectors. Hence, it demands efficient use of irrigation water which in turn improves 'productivity per unit of water'.
2. In many irrigation projects the overall efficiencies are in the range of 20 to 40%. Thus there is an urgent need to improve water conveyance systems, introduce water measurement and adopt better land leveling techniques to improve conveyance and distribution efficiencies.
3. Conjunctive use of both surface and ground water is to be practiced particularly for long duration crops for sustainable management of water resources. Whereever ground water pumping is in practice, it is recommended to adopt micro irrigation systems for improving water use efficiencies.
4. Large scale adoption of micro irrigation systems for field crops, orchards and vegetables is required for improving irrigation efficiencies upto 90-95% level.
5. 'Quality Control' in micro irrigation systems is necessary to ensure better hardware installations in the field. In view of the on going A.P. Micro Irrigation Project 2003 (APMIP, 2003) to bring 2.5 lakh ha under micro irrigation with an outlay of Rs. 12,000 crores, it is necessary to establish 'Testing Centres' for ensuring quality of Micro Irrigation Systems.
6. The technology of 'Subsurface Drainage' for control of water logging and soil salinity developed at Indo-Dutch Network Project, Bapatla which is economically viable and technically feasible can be adopted in large scale to reclaim affected irrigated lands under canal command areas.

### TECHNICAL SESSION - II : Farm Mechanization in Modern Agriculture

Two papers were presented under oral session, one on Impact of Machanization on Agricultural Production, Productivity and Employment Generation and the other on Studies on Aerobic Decomposition of Biomass. Under poster session one poster was displayed.

**Salient Recommendations :**

1. Farm mechanization is one of the key requirements in Indian Agriculture to improve farm productivity and also for timely completion of farm operations. Provision of easy credit facility and suitable subsidies to the farmers will help in improving the mechanization.
2. Establishment of "Custom Hiring and Agro Service Centres" is necessary to bring the benefits of farm mechanization to even small and marginal farmers.
3. Creation of 'Monitoring Cell' and 'Certifying Agencies' are required for proper coordination between Research and Development Centers, Government Agencies, Manufacturers and Farming Community.
4. Research studies on 'Decomposition of Biomass' is required to convert huge agricultural biomass into value added products to use as ingredients for enhancing the farm fertility.

### TECHNICAL SESSION - III : INTEGRATED NUTRIENT MANAGEMENT (INM)

A total of13 papers were presented including the lead paper under oral presentation, while 39 papers were displayed under poster session.

**Salient Recommendations :**

1. Sustainability is based on high input and high output principle.
2. Productivity potential in irrigated area needs to be exploited.
3. Alternate and efficient cropping and farming systems must be developed and popularized.
4. Balanced nutrition should be given due importance.
5. Integrated Nutrient Management involving both organic and inorganic sources has to be given due importance to meet the growing needs of the ever increasing population.
6. Organic manures can substitute 25 to 50 per cent of recommended nutrients and help in sustaining soil fertility and improving quality of produce.
7. Total organic farming can not be advocated to all situations. But, areas with negligible chemical use may be identified and it can be promoted in those areas.
8. As organic products fetch premium price, demand driven organic farming may be promoted in selected crops like rice and horticultural crops.
9. Integrated crop demonstrations involving all the disciplines should be resorted to attain sustainability.
10. Organic sources like green manures, corp residues, bio-fertilizers *etc.* need to be fully exploited.

## TECHNICAL SESSION - IV : Implications of WTO on Indian Agriculture

In all five papers were presented including a lead paper pertaining to "Implications of WTO on Indian Agriculture" under oral session and two papers were displayed under poster session.

**Salient Recommendations :**

1. Regulations of WTO should be taken as an opportunity to spread our own commodities worldover instead of too much of apprehension about it.
2. We have to be cautious about total patenting of various crop seeds by way of terminator genes.
3. Both pro and against opinions about genetically modified products were expressed. The following need attention.
   * BT cotton technology is said to be good for reducing chemical use and cost of cultivation. But, total replacement of chemical control with BT cotton may not be posible.
   * Golden rice is said to be a pro-poor technology. If no adverse effects occur with its use, it may be promoted to reduce Vitamin - A deficiency among rice farmers of developing world.
   * Roundup resistant soybean technology to promote increased herbicide usage is recommended. We may have to be cautious in accepting / promoting such technologies.

4. Subsidy to export commodities is negligible in India compared to developed countries like Japan, USA *etc.* It is necessary to provide subsidy to selected commodities to make them compete in world market because the cost of production in India is higher compared to other countries.

5. NGO's / Co-operative organizations should take lead in marketing / export of agricultural commodities like grapes in Maharashtra.

**TECHNICAL SESSION - V : Integrated Pest / Disease/ Weed Management (IPDWM)**

This session was held on 29-1-04 in which 17 participants have presented their papers including a lead paper under oral session, while 35 papers were presented under poster session. Among the 17 papers under oral session nine were on the Management of Insect Pests, five were on the Disease Management and three were on the Weed Management. Discussions have also taken place in view of the requirements of WTO and resource management for sustainable agriculture. During the session, Dr G.V. Ranga Rao, ICRISAT, Hyderabad has presented lead paper on IPM in grain legume crops. The speaker stressed on the major constraints of legume crops. The strategies suggested as future thrust are, frequent monitoring by periodic surveys, use of resistant varieties, knowledge on economic threshold levels, effective cultural operations, augmentation of natural enemies, use of less toxic chemicals to natural enemies and use of bio-pesticides. The speaker also stressed adoption of these practices to improve the health of ecosystem and increased profits through reduced inputs. Different observations after each presentation were discussed and recommendations, issues and directions for further research are given below.

**Salient Recommendations:**

**Rice**

Application of carbofuran 3 G @ 1.5 kg a.i.ha$^{-1}$ to nursery at 5 days before pulling is effective against early stage insect pests and best alterative to seedling root dip with chlorpyriphos 20 EC @ 0.02% and sustainable in rice - rice system.

**Coconut**

I. Management of rhinoceros beetle - *Oryctes rhinoceros* L.

- Pheromone traps - Rhinolure traps
- Release of baculovirus @ 10-15 inoculated beetles ha$^{-1}$.
- Spraying *Metarrhizium* solution on manure heaps.
- Sanitation along with mechanical hooking.

2. Management of Eriophyid mite - *Aceria guerreronis* (K.)

- Phytosanitary measures coupled with spraying of neem based pesticides (Azadirachtin) @ 0.004% at quarterly intervals during December - February, April - June and September - October.

**Betelvine**

Management of Phytophthora foot rot - *Phytophthora capsici*

- Integration of cultural, chemical and biological methods *viz.*, sanitation + bordeaux mixture 1% + *Trichoderma* sp in first year planted orchards. It is a remunerative treatment.

**Ber**

Management of fruit borer - *Meridarchis scyrods* (Meryick) and fruitflies - *Carpomyia vesuviana* (Costa.) and *Bactrocera correcta* (Bezzi).

- Module of application of monocrotophos 36 SC @ 0.036% at 12th week, dimethoate 30 EC @ 0.05% at 14th week and deltamethrin 2.8 EC 0.0014% + Jaggery 1% at 18th week along with field sanitation" is economical and ecologically sound.

**Sweet potato**

Management of sweet potato weevil - *Cylas formicarius*

- Use of pest free planting material dippied in monocrotophos @ 0.05%,
- Monitoring through pheromone traps.
- Re-riding the crop at 30 and 60 days after planting.
- Harvesting at 110 days, destruction of infested crop and continuation of pheromone traps till a fortnight after harvest.

Management of basal stem rot disease - *Ganoderma applanatum*

- Combined application of talc formulation of bio - agent -*Trichoderma* sp. @ 50 g + neem cake @ 5 kg / palm / year is effective.

**Bhendi**

Management of yellow vein mosaic virus disease

- Cultivation of VB6 is recommended in yellow vein mosaic virus disease endemic areas.

**Chillies**

Management of twig blight of chilli, *Choanephora cucurbitarum* (Berk. & Rav.) Thaxter.

- Application of copper oxychloride @ 3 g / lit at 30 days after planting checks the disease spread.

**Future Thrust:**

The following aspects are considered for future research to strengthen the recommendations in different crops.

**Rice**

- * Resurgence studies on the repeated application of imidacloprid, fipronil and thiomethoxam on insect pests of rice.

**Coconut**

- * Spraying technology / methodology to be worked out in manageing eriophyid mite.
- * Use of botanicals such as garlic extract and their combination with neem formulations in controlling eriophyid mite in coconut.
- * Root feeding technique with botanicals are to be worked out.

**Betel vine**

- * Phytophthora foot rot disease management in 2nd and 3rd year orchards.
- * Requirement of deep tillage operations and organic manures in the form of FYM and vermicompost are to be worked out in the management of soil borne fungi.

**Sugarcane**

- * Survey, surviellance and management of woolly aphid in sugarcane tracts of A.P.

**Weed Management**

- * Weed management using *Azolla* in rice - rice system.
- * Adoptability of using power weeder in maize, rice - maize system in A.P.

**Weather based models**

- * Weather based forecasting models have to be worked out for the management of insectpests and diseases in different crops.

**Organic farming**

- * Management of pests and diseases under organic farming situations in different crops has to be worked out.

## TECHNICAL SESSION - VI : BIODIVERSITY

In this Session a lead paper was presented by Dr. G. Lakshmi Kanth Reddy, Assoc Dean, Agricultural College, Bapatla. The paper brought out the need for conservation of agrobiodiversity. The main topics discussed were status and significance of agrobiodiversity, need for its conservation, systems and strategies for agrobiodiversity management, sustainable utilization of plant genetic resources and also suggested the need of strategies for effective conservation and sustainableuse of existing agrobiodiversity.

It was felt that the future areas for development lie in using the wide spectrum of available germplasm with high degree of genetic divergence and make legal efforts towards protecting the rights of the various stakeholders. It was followed by presentation of 12 papers on various crops namely finger millets, mungbean, rice and tomato on similar lines.

The use of GIS as an efficient tool for the analysis of spatial data for locating the sorghum diversity and its mapping has been conducted and also presented very nicely. Another study on rice hybrids identified the characters important for developing rice hybrids, which is expected to help breeders to develop hybrids and add to the genetic diversity with necessary characters of quality in terms of cooking and nutritive values.

The review on characterization of germplasm has brought out a case for use of expressed sequence tags as a cost effective and rapid approach for this purpose. The availability of high degree of genetic variability for use in tomato breeding has been observed in 20 genotypes for use in breeding programme covering different cultivars grown through out the length and breadth of the country.

Under poster session 19 papers were displayed.

**Salient Recommendations.:**

1. Favourable genes are to be identified, documented and utilized in breeding programmes.
2. Suitable measures should be taken to minimize the loss of biodiversity through forest fires, natural calamities and over exploitation.
3. Incentives should be given to the farmers for conserving and maintaining the genetic diversity.
4. Unexplored centers are to be identified to complete the gaps in germplasm collection.
5. GIS use for locating the sorghum diversity and its mapping has been conducted and similar studies in other crops should be encouraged.
6. Expressed sequence tags should be utilized as a cost effective and rapid approach for identification of species variation.

**TECHNICAL SESSION - VII : Post Harvest Handling, Food Processing and Nutritional Security**

A lead paper on food security for national development was presented by Dr(Mrs) Vijaya Khader, Dean, Home Science & Dean of Student Affairs i/c, ANGRAU, Hyderabad. She highlighted the food availability, food access and food utilization aspects for achieving food security. She suggested home gardening, education for increasing awareness towards Integrated Nutrient Management. She deplored the present trends towards use of fast food and the decreasing use of our traditional food habits. She also deplored the inability or the poor success in achieving the goals set by various national and international agencies towards achieving the food/nutritional security and also called for making the public distribution system more useful by including wheat, minor millets, soybean *etc.* to make available a wide range of food products which would help in meeting the nutritional requirements of the poor.

In another presentation methodologies for processing of turmeric for quality and value addition for domestic and international market were covered. Very simple and cost effective post- harvest tehcnologies and related machines like turmeric boiler, drier, grader and polisher available for this purpose were shown, stressesing the need to use these machinery to get quality product to make it competitive in the world market. The need for adopting the stringent quality standards for meeting the demands of international consumers was stressed and the case of Japan requiring turmeric from India was highlighted

A study on minor millets (little millet and fox-tail millet) revealed that they posses very good nutritional quality and should be used as quick cooking cereals and to prepare various value added products.

Under Poster Session five papers were presented.

**Salient Recommendations :**

1. Broad range programmes backed by sufficient national and international commitments to implement food security, nutritional security and health security to ever growing population is the need of the hour.
2. Household food security and nutritional requirement has to be met by empowering communities and individuals.
3. There is need to reduce post - harvest losses by adopting various improved post-harvest technologies and use of related processing machinery like turmeric boiler, drier, and polisher.
4. Value addition and processing of agricultural produce has to be adopted by farmers and they should attend to certain basic primary and secondary processing operations to get more profits.
5. Necessary post-harvest technology measures need to be transferred to the farmers to transform them from mere "Producer" to " Producer - cum - processor" to meet the national and international standards and get more profits by withstanding international competition.
6. Usage of minor millets like fox - tail millet and their food products need to be encouraged as they possess nutritional value required for body growth.
7. Wax emulsion 6 per cent was found to be effective in improving colour, carotenoid content and total sugar content of papaya and thereby improve storage and quality. Such methods may be adopted for other fruits and vegetables.

*The Andhra Agric.* J. **50** (3&4) : 188 - 193, 2003

# Effect on Growth, Fodder and Grain Yielding Potentiality of Sorghum [*Sorghum bicolor* (L.) Moench] Genotypes Mixed Grown with Cowpea as Influenced by Row Spacing Under Fodder - Food Production System

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## ABSTRACT

A field experiment was conducted during *kharif* 2000 at Agriculture College Farm, University of Agricultural Sciences, Dharwad on medium deep black clay soil under rainfed condition, to study the growth, fodder and grain yielding potential of sorghum genotypes (mixed grown with cowpea) as influenced by row spacing under fodder - food production system. Sweet sorghum genotype SSV-74 recorded significantly higher green fodder (45.26 t $ha^{-1}$) from main crop and grain yield (6.91 q $ha^{-1}$) from ratoon crop compared to rest of the sorghum genotypes. The higher green fodder yield is mainly due to significantly higher plant height, fresh weight, leaf area and total dry matter per plant. Higher cowpea green fodder yield was recorded in association with SPV - 462 and SSV - 74. Sweet sorghum genotype SSV-74 + cowpea mixture produced significantly higher mixed green fodder yield (53.51 t $ha^{-1}$) compared to rest of the mixtures. Wider row spacing of 45 cm had significant effect on ratoon sorghum grain yield (4.97 q $ha^{-1}$). Under fodder-food production system, sorghum green fodder equivalent yield (68.82 t $ha^{-1}$) was significantly higher with genotype SSV-74 + cowpea mixed cropping. The same mixed cropping system also recorded significantly higher net return and benefit cost ratio (Rs. 18364 $ha^{-1}$ and Rs.17247 $ha^{-1}$ net return and 2.64 and 2.48 B:C ratio at 45 cm and 30 cm row spacing, respectively) with higher palatability.

**Key words :** Sorghum genotypes, Mixed cropping, Cowpea, Row spacing, Fodder, Food.

The scarcity of green forage and grazing resources in the country have kept the livestock to suffer continuously with malnutrition resulting in their production potentiality at sub-optimum level as compared to developed nations. The present feed and forage resources of the country can meet only 46.60 per cent of the annual requirement. In India, area under forage crops is only 4.4 per cent of the total cultivated land (Fazlullah khan *et al.,* 2000) with the annual total forage production of 691 million tonnes. In Karnataka, only 3.5 per cent of the total cultivated land is under forage crops with the annual forage production and requirement of 91 million tonnes and 160 million tonnes, respectively (Anon., 1996). Thus there is large gap between availability and requirement of forage in India as well as in Karnataka. As it is not possible to increase the area under forage crops tangibly, because of demands for food and commercial crops, the only alternative is to strive for increasing the yield of forage per unit area per unit time following improved production technologies like introduction of suitable high yielding varieties of forage cereals and legumes under mixture and ratooning of suitable cultivars for better utilization of available moisture.

Sorghum is generally grown as an entire crop in large areas of Karnataka State. After the harvest of sorghum as main crop, either it is left for ratooning or second crop is generally taken in transition areas. In these areas, usually *kharif* sorghum is caught in rains and grain quality gets affected leading to lower market price.

To overcome these problems, during the *kharif* season, sorghum main crop can be harvested for green fodder and ratoon crop for grain purpose under fodder - food production system. Cowpea is one of the important legumes suitable to grow in combination with sorghum. It forms a good mixture with sorghum and increases the forage yield due to its synergistic effect. The study was therefore undertaken at Dharwad in Northern Transition Zone of Karnataka under rainfed conditions during *kharif* 2000 to study the productivity of sorghum genotypes, mixed grown with cowpea under fodder - food production system.

## MATERIAL AND METHODS

A field experiment was conducted at Agriculture College Farm, University of Agricultural Sciences, Dharwad, under rainfed condition during *Kharif 2000.* The soil of the experimental field was medium deep black clay with a pH 7.60, organic carbon 0.59 per cent, available nitrogen 350 kg $ha^{-1}$, available $P_2O_5$ 32 kg $ha^{-1}$ and available $K_2O$ 605 kg $ha^{-1}$.

The experiment consisted of four sorghum genotypes as main plot (SSV - 74, CSV-15, SPV-462 and Shiggaon - 3) and two row spacings as sub plot (30 cm and 45 cm) treatments. Cowpea was mixed grown with all the sorghum genotypes. The experiment was laid out in split plot design with four replications. In all the treatments, seed rate of 15 kg $ha^{-1}$ sorghum was mixed with 15 kg $ha^{-1}$ forage cowpea. Recommended dose of FYM (@ 5 t $ha^{-1}$) was applied to all the treatments and the dose of inorganic fertilizers used for main and ratoon crops were 75 : 50 : 25 kg N, $P_2O_5$ and $K_2O$ $ha^{-1}$ and 50 per cent of RDF (of main crop) respectively. Nitrogen was split into two doses for main crop (50% basal at sowing and 50% top dress 30 DAS).

In all the treatments, sorghum and cowpea were harvested from the net plot area at 50 per cent flowering stage of the sorghum genotypes. The stalk of both the crops were cut from net plot area at 10 cm above ground level and fresh weight of fodder was recorded separately and sorghum ratoon crop was harvested for grain and dry fodder purpose after physiological maturity. During the crop growth period rainfall of 399 mm was received.

## RESULTS AND DISCUSSION

### Effect of sorghum genotypes

The sorghum green fodder yield was significantly higher (18-21%) in SSV-74 (45.26 t $ha^{-1}$) compared to rest of the genotypes (Table 1). This yield increase is mainly due to significantly higher plant height (234.03 cm), fresh weight (405.50 g $plant^{-1}$) at harvest (Table 1). These results are in confirmity with Thippeswamy (1999) and Silli (1999).

Sweet sorghum genotype SSV-74 recorded significantly higher brix of 10.63 per cent compared to rest of the genotypes. The higher percentage of brix in sweet sorghum was also reported by Channa Naik and Jayakumar (1994). However, pop sorghum genotype Shiggaon-3 recorded significantly lower brix value (6.42%).

Ratoon crop of Shiggaon-3 produced significantly higher dry matter (3.01 t $ha^{-1}$) compared to rest of the genotypes (Table 2). This was mainly due to significantly taller plants (110.15 cm). Grain yield followed the similar trend of sorghum main crop green fodder yield that is, sweet sorghum genotype SSV-74 was significant yielder (6.91 q $ha^{-1}$) compared to rest of the genotypes. This was mainly due to significantly higher harvest index (27.38%) and 1000 grain weight (37.19 g) is SSV-74. These findings are in confirmity with Sankarapandian *et al.* (1995).

Table 1 : Effect of row spacing on growth and fodder yield of sorghum genotypes (main crop) mixed with cowpea, fodder yield of cowpea, mixture and palatability under fodder-food production system

| Treatments | Sorghum main crop | | | | | | | Cowpea | Mixed | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Plant height (cm) | No. of green leaves (plant$^{-1}$) | Leaf area (cm$^2$) plant$^{-1}$ | Dry matter (g plant$^{-1}$) | Fresh weight (g plant$^{-1}$) | Brix (%) | Green fodder yield (t ha$^{-1}$) | green fodder yield(t ha$^{-1}$) | (Sorghum + cowpea) green fodder yield (t ha$^{-1}$) | Palatability (%) |
| Genotypes | | | | | | | | | | |
| SSV-74 | 234.02 | 8.63 | 564.98 | 95.34 | 405.50 | 10.63 | 45.26 | 8.37 | 53.51 | |
| CSV-15 | 176.57 | 8.63 | 421.38 | 54.95 | 259.00 | 6.52 | 37.30 | 7.76 | 47.43 | |
| SPV 462 | 192.67 | 8.53 | 430.02 | 53.45 | 244.63 | 6.59 | 38.37 | 9.91 | 47.53 | |
| Shiggaon-3 | 245.07 | 8.55 | 465.79 | 87.10 | 314.50 | 6.42 | 37.29 | 6.91 | 45.20 | |
| S.Em ± | 3.93 | 0.08 | 18.84 | 4.65 | 15.02 | 0.34 | 1.38 | 0.61 | 0.79 | |
| CD (p=0.05) | 12.58 | NS | 60.27 | 14.89 | 48.06 | 1.10 | 4.43 | 1.95 | 2.54 | |
| Row spacing | | | | | | | | | | |
| 30 cm | 213.21 | 8.69 | 478.24 | 70.09 | 296.69 | 7.52 | 40.19 | 8.34 | 48.65 | |
| 45 cm | 210.96 | 8.56 | 462.84 | 75.33 | 315.13 | 7.55 | 38.92 | 8.14 | 48.18 | |
| S.Em ± | 1.71 | 0.06 | 10.92 | 0.74 | 3.30 | 0.19 | 0.48 | 0.16 | 0.39 | |
| CD (p=0.05) | NS | NS | NS | 2.27 | 10.18 | NS | NS | NS | NS | |
| Interaction | | | | | | | | | | |
| SSV-74 at 30 cm rows | 236.70 | 8.85 | 588.84 | 92.65 | 399.00 | 10.15 | 44.22 | 8.12 | 53.09 | 89.33 |
| SSV-74 at 45 cm rows | 231.35 | 8.40 | 541.12 | 98.03 | 412.00 | 11.11 | 46.30 | 8.63 | 53.93 | 86.00 |
| CSV-15 at 30 cm rows | 172.45 | 8.60 | 431.36 | 52.90 | 239.50 | 6.59 | 39.53 | 7.81 | 47.58 | 83.11 |
| CSV-15 at 45 cm rows | 180.70 | 8.65 | 411.40 | 57.00 | 278.50 | 6.45 | 35.07 | 7.72 | 47.28 | 74.83 |
| SPV-462 at 30 cm rows | 198.30 | 8.40 | 444.89 | 50.75 | 235.75 | 6.85 | 37.67 | 10.39 | 47.56 | 85.11 |
| SPV-462 at 45 cm rows | 187.05 | 8.65 | 415.14 | 56.15 | 253.50 | 6.33 | 39.07 | 9.43 | 47.50 | 77.42 |
| Shiggaon-3 at 30 cm rows | 245.40 | 8.55 | 447.86 | 84.05 | 312.50 | 6.51 | 39.34 | 7.06 | 46.40 | 79.00 |
| Shiggaon-3 at 45 cm rows | 244.75 | 8.55 | 483.71 | 90.15 | 316.50 | 6.33 | 35.24 | 6.77 | 44.01 | 75.00 |
| S.Em ± | 4.62 | 0.12 | 24.35 | 4.77 | 15.73 | 0.43 | 1.54 | 0.65 | 0.96 | - |
| CD (p=0.05) | NS | NS | NS | NS | NS | NS | 4.74 | NS | NS | - |

NS - Non Significant

Table 2 : Effect of row spacing on genotypes on growth and yield of sorghum ratoon crop, sorghum green fodder equivalent yield and economics under fodder-food production system

| Treatments | Sorghum main crop | | | | | | Sroghum | Economics * | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Plant height (cm) | No. of leaves (plant$^{-1}$) | Thousand grain weight (g) | Dry matter yield (t ha$^{-1}$) | Grain yield (q ha$^{-1}$) | Harvest index (%) | green fodder equivalent yield (t ha$^{-1}$) | Cost of cultivation (Rs. ha$^{-1}$) | Net returns (Rs. ha$^{-1}$) | B : C ratio |
| Genotypes | | | | | | | | | | |
| SSV-74 | 106.85 | 4.93 | 37.19 | 2.60 | 6.91 | 27.38 | 68.82 | | | |
| CSV-15 | 87.83 | 5.35 | 23.59 | 2.41 | 3.64 | 15.51 | 56.10 | | | |
| SPV 462 | 83.95 | 5.35 | 24.21 | 2.40 | 5.68 | 23.91 | 62.44 | | | |
| Shiggaon-3 | 110.15 | 5.50 | 14.59 | 3.01 | 2.69 | 9.13 | 54.18 | | | |
| S.Em ± | 4.93 | 0.21 | 0.50 | 0.09 | 0.10 | 0.84 | 2.28 | | | |
| CD (p=0.05) | 15.78 | NS | 1.59 | 0.28 | 0.31 | 2.70 | 7.30 | | | |
| Row spacing | | | | | | | | | | |
| 30 cm | 97.41 | 5.34 | 24.52 | 2.77 | 4.49 | 16.96 | 61.21 | | | |
| 45 cm | 96.98 | 5.23 | 25.27 | 2.44 | 4.97 | 21.01 | 59.57 | | | |
| S.Em ± | 0.84 | 0.08 | 0.33 | 0.08 | 0.09 | 0.53 | 0.55 | | | |
| CD (p=0.05) | NS | NS | NS | 0.23 | 0.27 | 1.62 | NS | | | |
| Interaction | | | | | | | | | | |
| SSV-74 at 30 cm rows | 107.55 | 5.00 | 36.08 | 2.82 | 6.55 | 23.75 | 67.33 | 6974 | 17247 | 2.48 |
| SSV-74 at 45 cm rows | 106.45 | 4.85 | 38.30 | 2.37 | 7.27 | 31.01 | 70.32 | 6974 | 18364 | 2.64 |
| CSV-15 at 30 cm rows | 89.95 | 5.40 | 23.35 | 2.63 | 3.46 | 13.31 | 58.64 | 6974 | 13812 | 1.98 |
| CSV-15 at 45 cm rows | 85.70 | 5.30 | 23.83 | 2.18 | 3.81 | 17.72 | 53.56 | 6974 | 12154 | 1.74 |
| SPV-462 at 30 cm rows | 81.25 | 5.40 | 24.63 | 2.37 | 5.49 | 23.25 | 62.67 | 6974 | 15336 | 2.20 |
| SPV-462 at 45 cm rows | 86.65 | 5.30 | 23.80 | 2.44 | 5.87 | 24.57 | 62.22 | 6974 | 15566 | 2.23 |
| Shiggaon-3 at 30 cm rows | 111.20 | 5.55 | 14.03 | 3.27 | 2.46 | 7.54 | 56.19 | 6974 | 13431 | 1.93 |
| Shiggaon-3 at 45 cm rows | 109.10 | 5.45 | 15.15 | 2.75 | 2.92 | 10.72 | 52.18 | 6974 | 12166 | 1.75 |
| S.Em ± | 5.07 | 0.23 | 0.68 | 0.14 | 0.16 | 1.12 | 2.41 | - | 638 | 0.09 |
| CD (p=0.05) | NS | NS | NS | NS | NS | NS | 7.44 | - | 1877 | 0.27 |

NS - Non significant * Economic analysis was done in RBD

Significantly higher cowpea green fodder yield was recorded in association with SPV-462 (9.91 t $ha^{-1}$) and SSV-74 (8.37 t $ha^{-1}$). It was significantly lower (6.91 t $ha^{-1}$) in association with Shiggaon-3 (Table 1). Delayed harvesting of cowpea in Shiggaon-3 due to its (sorghum's) late flowering (85 days) might have also reduced the cowpea yield due to senescence.

Though the associated cowpea green fodder yield was significantly affected by sorghum genotypes, the mixed (sorghum main crop + cowpea) green fodder yield followed similar trend as that of sorghum main crop yield. Significantly higher mixed green fodder yield in SSV-74 + cowpea mixture (53.51 t $ha^{-1}$) compared to other sorghum genotypes (Table 1) was mainly due to better performance of sorghum growth parameters. These results are in confirmity with Rao *et al.* (1976), Gill and Verma (1993).

### Effect of row spacing

The effect of spacing was non-significant for sorghum main crop green fodder yield, dry matter yield, cowpea green fodder yield and mixed green fodder yield.

Wider row spacing of 45 cm recorded significantly higher grain yield of 4.97 q $ha^{-1}$ (Table 2). This might be due to better utilization of moisture at wider row spacing as rainfall received was less during ratoon crop growth period and also due to significantly higher harvest index (21.01%) because of significantly lower dry matter yield (2.44 t $ha^{-1}$). However, plant height, number of leaves and 1000 grain weight were not affected by spacing.

### Interaction effect

Interaction effect was significant and similar for both sorghum main crop and sorghum green fodder equivalent yields under fodder - food production system. At both spacings, the sweet sorghum genotype SSV-74 produced significantly higher yields of 46.30 and 44.22 t $ha^{-1}$ sorghum main crop and 70.32 and 67.33 t $ha^{-1}$ sorghum green fodder equivalent yield at 45 and 30 cm row spacing respectively under fodder-food production system.

### Palatability

Higher palatability of 89.33 per cent was recorded in SSV-74 at 30 cm row spacing, followed by SSV-74 at 45 cm row spacing (86.00%). In general, sweet sorghum genotype SSV-74 was more palatable compared to other genotypes. Fodder grown in row spacing of 30 cm was more palatable compared to 45 cm row spacing. This was mainly due to significantly higher brix value (10.63%) in SSV-74. In closer spacing, the plants were tall, slender and more leafy resulting in increased palatability.

### Sorghum green fodder equivalent yield

Similar trend of sorghum main crop and ratoon grain yield followed here also (Table 2) with SSV-74 + cowpea mixture producing significantly higher sorghum green fodder equivalent yield (68.82 t $ha^{-1}$) which was on par with SPV-462 (62.44 t $ha^{-1}$). The effect of spacing was non-significant.

### Economics

Sweet sorghum genotype SSV-74 at both row spacings was significantly superior (Table 2) over rest of the treatment combinations (Rs. 18364 $ha^{-1}$, Rs. 17247 $ha^{-1}$, net returns and 2.64, 2.48 B : C ratio at 45 and 30 cm row spacing respectively). This was mainly due to significantly higher green forage yield of sorghum main crop, cowpea green forage yield and ratoon grain yield compared to other genotypes. These results are in agreement with Angadi (1986) and

Jayanthi *et al.* (1994).

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(Received on 10-09-2003 and revised on 21-01-2004)

*The Andhra Agric.* J. **50** (3&4) : 194 - 198, 2003

# Effect of Saline Water Irrigation, Organics and Nitrogen on Yield and Yield Attributes of Jowar (*Sorghum bicolor* L.)

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## ABSTRACT

A field experiment conducted during *kharif* seasons of 1990 and 1991 revealed that irrigation levels did not influence the yield of Jowar. However, different organic manures and nitrogen alone or their combination had a significant effect on yield and yield attributing characters of jowar when irrigated with saline water. Maximum grain yield was obtained with Daincha @ 5 t/ha + 50 kg N/ha followed by FYM @ 15 t/ha + 50 kg N/ha treatments in the first year while 125 kg N/ha treatments in the second year, whereas FYM @ 15 t/ha + 50 kg N/ha and 125 kg N/ha gave constantly higher straw yield in both the years of study.

**Key words ;** Saline water irrigation, Organics, Nitrogen, Yield, Yield attributes, Jowar.

Jowar is one of the important cereal crops grown in India (11.2m ha area and 9.0 m t production during 1996 - 97), but its productivity is very low (655 kg/ha) compared to other jowar growing countries. In Andhra Pradesh, it is grown in larger area with low productivity. The reasons for its low productivity is improper fertilizer management besides use of poor quality of irrigation water available in coastal belt of the state due to ingress of sea water in the ground water (Anonymous, 1986). Though jowar crop responds well to fertilizer application, most of the farmers seldom apply organics or inorganic fertilizers, resulting in poor productivity of the crop. Generally, soils irrigated with poor quality waters are low in their fertility status, especially in N or sometimes P. Better crops can be grown by raising the fertility status by the addition of organic residues and manures (Singh and Singh, 1991). This calls for judicious fertilizer management practices for stepping up crop productivity. Since information on effect of saline water irrigation alone and in combination with organics or inorganics is meagre, and this experiment was conducted.

## MATERIAL AND METHODS

A field experiment was conducted during the *kharif* seasons of 1990 and 1991 on clayey soil at the Agricultural College Farm, Bapatla (A.P.). The soil was low in available N (235 kg/ha), P (7.5 kg/ha), K(120 kg/ha) and organic carbon (0.46%) with a pH of 7.8 and EC 0.5 dS/m. The organic manures as per the treatments (Table - 1) were incorporated a fortnight before sowing of the crop. A common basal dose of 40 kg $P_2O_5$/ha and 30 kg $K_2O$/ha was given through single super phosphate and muriate of potash, respectively. Nitrogen as per treatments in the form of urea was applied in two splits equally as a basal and 30 days after sowing of the crop. Three irrigations were given each at 6 cm depth as per treatment i.e. Best Available Water (BAW) to block I and saline irrigation water (EC 12 dS/m) to block II in each replication. The experiment was laid out in a split plot design in micro plots of 2.5 x 2.5 $m^2$ separated by polythene sheets up to a depth of 90 cm with irrigation levels as main plots and organic manures and nitrogen alone and their combinations as sub-plots. There were 24 treatments (2main treatments and 12 sub-treatments which were given as in Table-1) replicated thrice. The crop was sown on 23-8-90 and 2-8-91 during 1st and 2nd years, respectively using the CV. CSH-9. Interculture operations and need based plant protection measures were followed. The crop was harvested on 18-12-90 and 2-12-91 during first and second years, respectively. At the time of harvest, data on biometric observations were recorded on 5 randomly selected plants. Yield and yield attributing characters were also recorded at the time of threshing of the produce on the same plants and the data were subjected to standard statistical analysis. The results are presented in Table-1.

## RESULTS AND DISCUSSION

### Effect of irrigation levels :

The data (Table - 1) revealed that none of the characters studied was significantly influenced by irrigation levels in both the years. However, good quality irrigation (i.e. BAW) produced higher grain yield and other characters compared to saline irrigation water (EC 12 dS/m). The poor yield obtained with saline water irrigation may be due to decreased yield attributing characters (Tables - 1&2). The results are in conformity with the findings of Keshwa and Singh (1988) who had reported that the productivity of both soils and crops of saline well watered areas declined with the continuous use of such poor quality well waters.

### Effect of organics and nitrogen :

The data (Tables - 1&2) showed that yield and yield attributing characters studied were significantly influenced by various sub-treatments under test during both the years.

Significantly the highest grain yield was recorded with Daincha @ 5 t/ha + 50 kg N/ha followed by FYM @ 15 t/ha + 50 kg N/ha during 1990 and 125 N/ha alone followed by Daincha @5 t/ha + 50 kg N/ha during 1991. The grain yield loss (22.1% and 27.9% during first and second years respectively) due to saline water irrigation over control could be compensated up to 48.7% and 42.1% by the application of FYM @ 5 t/ha + 50 kg N/ha and 125 kg N/ha alone during 1990 and 1991, respectively.

The increase in grain yield under saline water irrigation with FYM @ 15 t/ha + 50 kg N/ha and 125 kg N/ha application alone during first and second years, respectively due to more availability of plant nutrients.

The grain and straw yield are generally higher under BAW compared to saline irrigation treatment, which may be due to shorter earhead length and lesser test weight recorded with saline water irrigation treatment.

Maximum straw yield was recorded with FYM @ 15 t/ha + 50 kg N/ha treatment during both the years and found significantly superior to rest of the treatments under test. But under saline irrigated conditions, more straw yield was obtained with Daincha @5 t/ha + 50 kg N/ha during 1990 and 125 kg N/ha alone treatments during 1991.

Application of FYM @ 15 t/ha and 50 kg N/ha gave significantly higher test weight in the first year while Daincha @ 5 t/ha and 50 kg N/ha recorded maximum test weight during second year and they were found significantly superior to other sub-treatments under test. However, the highest test weight was recorded with FYM @ 15 t/ha + 50 kg N/ha treatment under saline irrigated conditions during both the years of study.

Longest earheads were produced by the application of FYM @ 15 t/ha + 50 kg N/ha treatments which may be due to balanced nutrient supply to plants and also due to the beneficial effect of organic manures i.e. FYM or Daincha under saline irrigated conditions by

Table 1 : Yield and Yield attributes of Jowar as influenced by saline irrigation, organic manures and inorganic nitrogen during *Kharif* 1990.

| Treatment | *KHARIF* 1990 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ear head length (cm) | | | Test Weight (g/1000 grains) | | | Grain Yield (Kg/ha) | | | Straw Yield (Kg/ha) | | |
| | BAW | 12EC | Mean | BAW | 12EC | Mean | BAW | 12EC | Mean | BAW | 12EC | Mean |
| T1 : Control (No'N') | 19.6 | 19.5 | 19.6 | 21.4 | 18.8 | 20.1 | 2175 | 1694 | 1935 | 8425 | 6667 | 7456 |
| T2 : Nitrogen (Urea) @ 50 Kg N/ha | 20.8 | 21.8 | 21.3 | 21.6 | 19.4 | 20.5 | 2972 | 2925 | 2949 | 9631 | 7778 | 8704 |
| T3 : Nitrogen (Urea) @ 100 Kg N/ha | 24.1 | 21.7 | 22.9 | 22.3 | 22.2 | 22.3 | 3492 | 3369 | 3430 | 11389 | 8889 | 10139 |
| T4 : Nitrogen (Urea) @ 125 Kg N/ha | 22.4 | 21.5 | 21.9 | 23.4 | 22.6 | 23.0 | 3472 | 3259 | 3500 | 11714 | 8611 | 10162 |
| T5 : Diancha @ 5 t/ha | 19.6 | 19.8 | 19.7 | 21.8 | 21.3 | 21.6 | 3325 | 2853 | 3088 | 7592 | 8147 | 7870 |
| T6 : Subabul @ 5 t/ha | 20.3 | 20.0 | 20.2 | 20.9 | 19.8 | 20.4 | 3008 | 2953 | 2981 | 9444 | 9306 | 9375 |
| T7 : FYM @ 15 t/ha | 21.9 | 20.4 | 21.2 | 20.3 | 22.8 | 21.6 | 2833 | 2528 | 2680 | 7592 | 7408 | 7500 |
| T8 : Groundnut shells @ 5 t/ha | 20.7 | 21.6 | 21.2 | 19.6 | 20.3 | 19.9 | 3083 | 2953 | 3019 | 8842 | 9861 | 9352 |
| T9 : T5 + T2 | 21.5 | 23.3 | 22.4 | 21.3 | 22.2 | 21.7 | 4444 | 3389 | 3917 | 9631 | 10694 | 10162 |
| T10 : T6 + T2 | 21.9 | 21.9 | 21.9 | 21.1 | 23.2 | 22.2 | 3325 | 2981 | 3153 | 9444 | 10092 | 9769 |
| T11 : T7 + T2 | 23.8 | 22.8 | 23.3 | 25.4 | 24.2 | 24.8 | 4297 | 3472 | 3884 | 10694 | 10000 | 10347 |
| T12 : T8 + T2 | 21.6 | 22.3 | 21.9 | 24.7 | 24.2 | 24.4 | 3492 | 3056 | 3273 | 9908 | 10508 | 10208 |
| CD 0.05 (Main treatment) | | NS | | | NS | | | NS | | | NS | |
| CD 0.05 (Sub treatments) | | 1.9 | | | 1.5 | | | 450 | | | 1862 | |
| CD 0.05 (Interaction) | | NS | | | NS | | | 130 | | | 538 | |

NS - Non Significant    BAW : Best Available Water    12EC = Saline irrigation with EC 12 ds/m

Table 2 : Yield and Yield attributes of Jowar as influenced by saline irrigation, organic manures and inorganic nitrogen during *Kharif* 1991.

| Treatment | *KHARIF* 1991 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ear head length (cm) | | | Test Weight (g/1000 grains) | | | Grain Yield (Kg/ha) | | | Straw Yield (Kg/ha) | | |
| | BAW | 12EC | Mean | BAW | 12EC | Mean | BAW | 12EC | Mean | BAW | 12EC | Mean |
| T1 : Control (No'N') | 15.2 | 16.2 | 15.7 | 16.5 | 15.6 | 16.1 | 795 | 573 | 684 | 6499 | 4194 | 5347 |
| T2 : Nitrogen (Urea) @ 50 Kg N/ha | 17.2 | 19.1 | 18.1 | 17.6 | 17.5 | 17.6 | 1327 | 1088 | 1208 | 7974 | 4955 | 6925 |
| T3 : Nitrogen (Urea) @ 100 Kg N/ha | 18.3 | 19.8 | 19.0 | 19.6 | 18.1 | 18.9 | 1710 | 1572 | 1641 | 8896 | 6845 | 7870 |
| T4 : Nitrogen (Urea) @ 125 Kg N/ha | 19.5 | 19.3 | 19.4 | 20.0 | 19.2 | 19.6 | 1959 | 1940 | 1950 | 9357 | 7467 | 8412 |
| T5 : Diancha @ 5 t/ha | 15.5 | 15.7 | 15.6 | 23.0 | 21.0 | 22.0 | 1535 | 1618 | 1576 | 7974 | 5808 | 6891 |
| T6 : Subabul @ 5 t/ha | 17.7 | 17.5 | 17.6 | 20.4 | 17.3 | 18.9 | 1002 | 1166 | 1129 | 6845 | 4517 | 5681 |
| T7 : FYM @ 15 t/ha | 19.4 | 19.0 | 19.2 | 21.4 | 21.4 | 21.4 | 1871 | 1189 | 1530 | 8826 | 7282 | 8055 |
| T8 : Groundnut shells @ 5 t/ha | 17.3 | 15.5 | 16.4 | 18.0 | 20.1 | 19.0 | 1060 | 1166 | 1113 | 8896 | 5900 | 7398 |
| T9 : T5 + T2 | 20.4 | 21.2 | 20.8 | 26.7 | 21.6 | 24.2 | 1858 | 1581 | 1719 | 9311 | 6068 | 7689 |
| T10 : T6 + T2 | 19.9 | 20.3 | 20.1 | 21.4 | 21.1 | 21.2 | 1415 | 1323 | 1369 | 6545 | 6960 | 6752 |
| T11 : T7 + T2 | 23.0 | 22.2 | 22.6 | 24.0 | 21.4 | 22.6 | 1447 | 1613 | 1530 | 9633 | 7328 | 8481 |
| T12 : T8 + T2 | 18.1 | 16.3 | 17.2 | 21.6 | 20.6 | 21.1 | 1249 | 1613 | 1431 | 8273 | 7197 | 7735 |
| CD 0.05 (Main treatment) | | NS | | | NS | | | NS | | | NS | |
| CD 0.05 (Sub treatments) | | 3.3 | | | 4.6 | | | 711 | | | 2082 | |
| CD 0.05 (Interaction) | | NS | | | NS | | | | 205 | | 601 | |

NS - Non Significant BAW : Best Available Water 12EC = Saline irrigation with EC 12 ds/m improving the physico-chemical properties of the soil. Similar results were also reported by several workers like Veerabadran and Rajendran (1993). Patel *et al.* (1993), Keshawa and Singh (1988) and Reddy *et al.* (1982) who reported the beneficial effects of use of amendments on different soils and crops.

**Interaction effect :**

There were significant differences between the main and sub-treatments on grain and straw yield of jowar crop only. It clearly indicated that, different organic manures and nitrogen alone or their combination had a significant effect on grain and straw yield of jowar when irrigated with saline water (Tables 1&2).

It can be concluded that under saline irrigated conditions, jowar crop can be successfully raised by applying Daincha @ 5 t/ha + 50 kg N/ha or FYM @ 15 t/ha + 50 kg N/ha depending upon the availability of organic manures in the surroundings to compensate for the yield losses that are likely to be occur under saline irrigated conditions.

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(Received on 22-04-2003 and revised on 30-12-2003)

*The Andhra Agric.* J. **50** (3&4) : 199 - 202, 2003

# Yield and Nutritive Value of Fodder Sorghum Varieties as Influenced by Different Levels of Nitrogen

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## ABSTRACT

Study conducted in Bapatla of Guntur district of Andhra Pradesh on the yield and nutritive value of fodder sorghum varieties SSG.59-3 and MFSH-4 as influenced by different levels of nitrogen 0,40,80 and 120 kgha$^{-1}$ revealed that MFSH-4 recorded significantly higher tiller production, dry matter accumulation green and dry fodder yields. The differences between the two varieties with respect to crude protein per cent were more significant. However, significantly higher crude fibre per cent was obtained with SSG.59-3 and higher crude protein and crude fibre yields were obtained with MFSH-4. Nitrogen uptake and nitrogen use efficiency was significantly more with MFSH-4. Increment in the dose of nitrogen significantly increased the tiller number, dry matter production, forage yields, crude protein per cent and yield. The highest crude protein per cent and yield of 6.7 and 30.0 q ha$^{-1}$, respectively was obtained with the application of nitrogen at 120 kgha$^{-1}$. Increase in nitrogen application increased the N uptake while, nitrogen use efficiency decreased with each incremental dose of nitrogen.

**Key words :** Nutritive Value, Fodder Sorghum

Scarcity of quality fodders with adequate nitrogen nutrition considered to be a major limiting factor for achieving higher milk production, owing to land and input constraints under increasing population pressure. The required quantities of green and dry fodders with higher protein per cent and lower fibre were not met to the cattle. As a result even though India has a striking figure of 15% of world cattle population, contributed only 3% of the world milk production.

Fodder sorghum is the cheapest and a valuable fodder and because of its higher protein content. Since nitrogen fertilization plays an important role in increasing the yield and nutritive value of the forage, identification of suitable variety with higher yield and good nutritive values is important for realizing optimum yield of good quality fodder. Keeping this in view present investigation was carried out to find out a suitable variety with higher yield and nutritive value under varied levels of nitrogen.

## MATERIAL AND METHODS

A field investigation was conducted at Agricultural College Farm, Bapatla in a randomize block design with factorial concept with two varieties of fodder sorghum viz., SSG.59.3 and MFSH-4 and four levels of nitrogen 0, 40, 80 and 120 kg ha$^{-1}$. The soil was clay loam in texture with available N,P,K ratio of 150 : 16 : 520 kg ha$^{-1}$, respectively. Entire doses of $P_2O_5$ and $K_2O$ were applied basally @ 40 kg ha$^{-1}$, along with half of the nitrogen as per the treatments and the remaining dose of nitrogen was applied 40 days after sowing by placement method.

Biometric observations recorded in respect of both growth and yield parameters following standard practices. Similarly plant analysis as well as quality parameters were derived adopting standard methods.

## RESULTS AND DISCUSSION

Variety MFSH-4 produced higher no. of tillers per plant, dry matter, green and dry fodder yields. However, quality parameters Viz. N uptake and N use efficiency, significant differences were not observed between two varieties with crude protein per cent. However, significantly more crude protein yield of 4.4 q ha$^{-1}$ was realized with MFSH-4. The higher crude fibre per cent was recorded with SSG. 59-3 (32.80), whereas Crude fibre yield was significantly more with MFSH-4 (25.9 q ha$^{-1}$). Nitrogen uptake and nitrogen use efficiency were more with MFSH-4. The superiority of MFSH-4 over SSG. 59-3 may be due to its genetic makeup and potentiality of the hybrid to produce more number of tillers and to accumulate higher dry matter in turn increased the fodder yields. Forage with less fibre and more protein was relished by the cattle. In the present investigation, MFSH-4 had less fibre content and more drymatter production as a result significantly higher crude protein and fibre yields coupled with higher uptake of nitrogen more N use efficiency than SSG. 59-3. Similar results were hither to reported (Malik *et al.*,1992; Shinde *et al.*, 1987 ; Patel *et al.*, 1994).

### Effect of Nitrogen levels

The increasing trend of number of tillers per plant dry matter, green and dry fodder yields were observed with increase in the level of nitrogen up to 120 kg ha$^{-1}$. Higher doses of nitrogen might have provided larger photosynthetic surface area to intercept more radiant energy which might have ultimately resulted higher tiller production and more dry matter accumulation. These results are in confirmity with the findings of Khot *et al.* (1991) and Patel *et al.* (1994). Crude protein and fibre yields are also increased with increment in the dose of nitrogen. Nitrogen application at the highest level synthesized more crude protein (6.7) the reason being, nitrogen as a constituent of amino acids, nucleic acids, Co-enzymes, nucleotides and proteins (Evans and Sargar, 1966) might have attributed to increase in crude protein per cent due to the availability of nitrogen at higher levels. Similar results were also reported by Patel *et al.* (1994). Nitrogen application does not have any influence on crude fibre per cent but each incremental dose of nitrogen contributed significantly in increase in the crude protein and crude fibre yields. This may be due to higher dry matter production coupled with crude protein and fibre content of the respective treatments. Present results are in tune with (Raj and Patel, 1988). Nitrogen uptake increased with increment in the dose of nitrogen up to 120 kg ha$^{-1}$. On the contrary nitrogen use efficiency decreased with increase in the level of nitrogen. The increased uptake might be due to increase in trend of nitrogen content in the dry matter. The decrease in nitrogen use efficiency with increase in the level of nitrogen might be due to operation of law of diminishing returns. These results are in accordance with the findings of Byale *et al.* (1987) and Sairam *et al.* (1991).

### Interaction of Variety and Nitrogen

The variety and nitrogen interaction effects were significant with all the parameters under study except for crude fibre content. Both the varieties under trial responded significantly with increase in the level of nitrogen up to the highest level tried. Variety MFSH-4, found to be significantly superior to SSG.59-3 at the same level of nitrogen application. The higher tiller number (7.1), Dry matter (1042 gm$^{-2}$), Green fodder yield (393 q ha$^{-1}$), Dry fodder yield (124 q ha$^{-1}$), Crude protein per cent (6.12), Crude protein yield (7.6 q ha$^{-1}$), Crude fibre yield (37.8 q ha$^{-1}$), N uptake (121.5 kg ha$^{-1}$), and nitrogen use efficiency (60.95%) are obtained with MFSH-4 at 120 kg N ha$^{-1}$. This treatment combination was found significantly superior to rest of the treatmental combinations. This may

Table 1 : Dry matter production yield and nutritive characters of fodder sorghum varieties as effected by varieties and levels of nitrogen.

| Treatment | Dry matter Production (gm$^{-2}$) | No of Tillers per plant | Green fodder Yield (q ha$^{-1}$) | Dry fodder Yield (q ha$^{-1}$) | Crude protein (%) | Crude protein Yield (q ha$^{-1}$) | Crude fibre (%) | Crude fibre Yield (q ha$^{-1}$) | N up take (kg ha$^{-1}$) | NUE (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Varieties | | | | | | | | | | |
| SSG.59-3 | 574.2 | 4.3 | 187 | 64 | 4.59 | 3.2 | 32.80 | 21.3 | 53.6 | 45.20 |
| MFSH - 4 | 743.8 | 4.8 | 257 | 85 | 4.66 | 4.4 | 30.40 | 25.9 | 70.0 | 54.38 |
| Nitrogen levels | | | | | | | | | | |
| (Kg ha$^{-1}$) | | | | | | | | | | |
| 0 | 283.0 | 2.2 | 90 | 33 | 2.84 | 0.9 | 29.7 | 10.0 | 15.1 | 0.0 |
| 40 | 581.5 | 3.9 | 183 | 63 | 4.44 | 2.6 | 29.7 | 18.8 | 44.1 | 75.17 |
| 80 | 799.4 | 5.5 | 252 | 87 | 5.46 | 4.8 | 29.8 | 26.1 | 78.1 | 67.82 |
| 120 | 921.8 | 6.7 | 346 | 100 | 6.77 | 6.7 | 29.9 | 30.0 | 107.7 | 56.17 |
| SEM ± | 10.7 | 0.03 | 5 | 0.8 | 0.09 | 0.1 | 0.05 | 0.2 | 0.9 | 0.14 |
| CD (0.05p) | 29.8 | 0.10 | 8.8 | 3.8 | 0.24 | 0.3 | 0.15 | 0.6 | 2.5 | 0.41 |

Table 2 : Variety and nitrogen interaction on yield and nutritive characters of fodder sorghum varieties.

| Variety X Nitrogen | Dry matter Production (gm$^{-2}$) | | No of Tillers per plant | | Green fodder Yield (q ha$^{-1}$) | | Dry fodder Yield (q ha$^{-1}$) | | Crude protein (%) | | Crude protein Yield (q ha$^{-1}$) | | Crude fibre Yield (q ha$^{-1}$) | | N up take (kg ha$^{-1}$) | | Nitrogen Use Efficiency (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N-Levels | SSG.59-3 | MFSH-4 | SSG.59-3 | MFSH-4 | SSG.59-3 | MFSH-4 | SSG.59-3 | MFSH-4 | SSG.59-3 | MFSH-4 | SSG.59-3 | MFSH-4 | SSG.59-3 | MFSH-4 | SSG.59-3 | MFSH-4 | SSG.59-3 | MFSH-4 |
| 0 | 224.5 | 318.9 | 2.0 | 2.5 | 96 | 115 | 34 | 39 | 2.62 | 2.91 | 1.0 | 1.2 | 11.4 | 12.1 | 14.5 | 18.6 | 0.0 | 0.0 |
| 40 | 481.3 | 718.5 | 3.8 | 4.0 | 174 | 221 | 57 | 76 | 3.79 | 4.37 | 2.2 | 3.3 | 18.9 | 23.1 | 34.9 | 53.2 | 67.5 | 82.85 |
| 80 | 667.3 | 969.8 | 5.3 | 5.8 | 2.00 | 318 | 76 | 105 | 4.95 | 5.25 | 3.8 | 5.5 | 25.2 | 32.2 | 68.0 | 89.0 | 61.9 | 73.75 |
| 120 | 829.6 | 1042.5 | 6.4 | 7.1 | 257 | 393 | 84 | 124 | 7.00 | 6.12 | 5.9 | 7.6 | 27.8 | 37.8 | 94.9 | 121.5 | 51.4 | 60.95 |
| SEM ± | 21.5 | 21.5 | 0.06 | 0.06 | 7 | 7 | 1.5 | 1.5 | 0.19 | 0.19 | 0.3 | 0.3 | 0.5 | 0.5 | 1.3 | 1.3 | 0.23 | 0.23 |
| CD (0.05p) | 59.6 | 59.6 | 0.2 | 0.2 | 21 | 21 | 4 | 4 | 0.53 | 0.53 | 0.7 | 0.7 | 1.3 | 1.3 | 3.6 | 3.6 | 0.58 | 0.58 |

be due to the genetic make up of the variety coupled with application of nitrogen at higher levels showed its fullest potential in enhancing the yield and nutritive characters. From the above results, it is finally concluded that high yields of good quality fodder can be obtained by cultivating MFSH-4 at 120 kg N ha$^{-1}$.

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(Received on 05-04-2002 and revised on 20-05-2003)

*The Andhra Agric.* J. **50** (3&4) : 203 - 206, 2003

# Evaluation of Frontline Demonstration Trials on Urdbean and Mungbean in Guntur District of Andhra Pradesh Under Rainfed Conditions

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## ABSTRACT

Frontline demonstration trials were conducted for two consecutive years at different locations to study the economic feasibility of technology transfer and adoption in urdbean and mungbean. It revealed that the considerable gaps existed in potential and demonstration yields in respect of both blackgram and greengram due to lack of efficient technology for predicting cyclonic weather and also extension gaps.

**Key words :** Front Line Demonstrations, Urdbean, Mungbean, Rainfed.

The extension gaps for both the crops are lower as the adoption of technology (adoption index) was more, indicating on an average 74.9 per cent. This ultimately highlighted the adverse impact of cyclonic weather frequently prevailed in this belt during *Kharif*; and diluting the technology existed for normal conditions. Therefore, a suitable variety and technology are still needed for cyclone prone areas to enhance the pulse production.

Pulse production has remained static for the past five decades in the country as these crops are usually grown in rainfed areas where more risk is involved and the chances of crop failure are high; and more so in cyclone prone areas of K.G. zone of Andhra Pradesh during *kharif* season. In addition to this, these crops are being grown by marginal farmers with limited resources and some times even facing difficulty in adoption of technology existed, for which our scientists are claiming high while stating that the available technology and varieties are good enough to double the pulse production from the present level (Yadav *et al.,* 1998). In view of this, a special project on "Frontline Demonstration on pulse crops" was started under National Pulses Development Project by ICAR in the nineties in order to demonstrate the production potentials and benefit of latest technologies vis - a - vis farmers practices.

Keeping in view, an attempt has been made to study the yield gaps between FLD's carried out by scientists in farmers fields and farmers practices usually adopted by them; and also the extent of technology adoption and additional benefit cost ratios.

## MATERIAL AND METHODS

A total of 40 frontline demonstrations were conducted in the Guntur district of Andhra Pradesh during the *Kharif* season of 1996 and 1997. The cross sectional data on output of both the crops and inputs used per hectare have been collected from the demonstration trials. In addition to this, data on farmers practices have also been collected.

The gap of technology and extension and technology and adoption index have been calculated by using the following formula:

a) Technology gap = Pi - Di

b) Extension gap = Di - Fi

c) Technology index $= \frac{Pi - Di}{Pi} \times 100$

Where

Pi = potential yield of $i^{th}$ crop.

Di = demonstration yield of the $i^{th}$ crop.

Fi = farmer's yield of the $i^{th}$ crop.

d) Technology index $= \frac{Ai}{Ri} \times 100$

Where

Ai = adoption score obtained by the farmer for the $i^{th}$ crop.

Ri = possible maximum score of the $i^{th}$ crop. [List of recommended practices and each one was assigned a score of 1]

Additional benefit was worked-out from the data on additional yield obtained by adopting improved variety and technology over the farmers practice, considering prevailing market price.

Yield of the frontline demonstration trials and potential yield of the respective crops were compared to estimate the yield gaps which were further categorized into technology and extension gaps.

## RESULTS AND DISCUSSION

### Technology Gap

Though the FLD trials were conducted under the direct supervision of the scientists in the farmers fields, the gap between the potential yield and the demonstration yield was existed in both the crops. The highest technology gap (2.9 q/ha) was recorded with blackgram and the lowest (1.2 q/ha) was observed in greengram (Table - 1). This is due to the soil fertility and weather, particularly occurrence of cyclonic rains during the crop period. Hence, the location specific recommendations are necessary to bridge this gap.

### Extension Gap

The extension gap for both the crops is almost same and lower than that of technology gap, which obviously indicated that the farmers are well aware of high yielding varieties and latest technology as the farmers of this belt are more progressive and educated but often recording lower yields due to cyclonic rains rather than unawareness of existing technology.

### Technology and adoption index

The adoption of technology in FLD trials was estimated through technology index, while the recommended package of practices for each crop followed by farmer in general was assessed by adoption index. Technology index clearly indicated the feasibility of the evolved technology on the farmer's field. The lower the value of the technology index more is the feasibility of the technology. Technology index was highest in black-gram indicating a wide gap existed between the technology evolved at research farms and its implementation during demonstration in farmers fields (Table I). Similar results were reported Kadian *et al.* (1997).

The adoption index was more in greengram due to various factors, such as : its suitability to fit into various cropping systems and higher market price prevailed for this crop. The adoption of recommended practices in FLD's on pulses has increased the yield as compared to the farmer's practices (Nigam and Singh, 1997). The percentage increase in yield over control was higher in blackgram than that of greengram (Table - 1).

The comparative returns of both the crops have been studied by estimating the additional

Table 1 : Yield gaps, technology and adoption index for blackgram and greengram.

| Crop / Variety | Season / Year | No. of locations * | Average yield under normal conditions (potentialyield) | Under frontline Demonstration | Under farmers practices | % increase in yield over control/Farmers | Technology gap | Extension gap | Technology index (%) | Adoption index (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Blackgram** | ***Kharif*** | | | | | | | | | |
| LBG 623 | 1996 | 10 | 12 | 10.2 | 8.8 | 15.9 | 1.8 | 1.4 | 15 | 57.1 |
| LBG 623 | 1997 | 10 | 12 | 8.0 | 7.5 | 6.7 | 4.0 | 0.5 | 33 | 71.4 |
| | Mean | 10 | 12 | 9.1 | 8.1 | 11.3 | 2.9 | 0.9 | 24 | 64.2 |
| **Greengram** | ***Kharif*** | | | | | | | | | |
| LGG 460 | 1996 | 10 | 12 | 9.8 | 8.7 | 12.6 | 2.2 | 1.1 | 18 | 83.3 |
| LGG 460 | 1997 | 10 | 12 | 11.9 | 11.2 | 6.2 | 0.1 | 0.7 | 1 | 66.6 |
| | Mean | 10 | 12 | 10.8 | 9.9 | 9.4 | 1.2 | 0.9 | 9.5 | 74.9 |

* Total Area Covered = 16.2 ha

Table 2 : Additional cost and returns of different crops (Rs/ha)

| Season /Year | Particulars | Total Cost | Gross Returns | Net Returns | Additional cost | Additional Return | Additional benefit cost ratio |
|---|---|---|---|---|---|---|---|
| **Blackgram** | | | | | | | |
| 1996 | Improved | 8645 | 16320 | 7675 | 600 | 2240 | 3.73 |
| | Local | 8045 | 14080 | 6035 | - | - | - |
| 1997 | Improved | 8500 | 12800 | 4300 | 550 | 800 | 1.45 |
| | Local | 7950 | 12000 | 4050 | - | - | - |
| Mean | Improved | 8572 | 14560 | 5988 | 575 | 1440 | 2.50 |
| | Local | 7997 | 12960 | 4963 | - | - | - |
| **Greengram** | | | | | | | |
| 1996 | Improved | 9880 | 17640 | 7760 | 830 | 1980 | 2.38 |
| | Local | 9050 | 15660 | 6610 | - | - | - |
| 1997 | Improved | 9600 | 21420 | 11820 | 700 | 1260 | 1.80 |
| | Local | 8900 | 20160 | 11260 | - | - | - |
| Mean | Improved | 9740 | 17820 | 8080 | 765 | 1620 | 2.12 |
| | Local | 8975 | 16920 | 7945 | - | - | - |

Price of Blackgram - Rs. 1600/ q Price of Blackgram - Rs. 1800/q benefit - cost ratios and results have been presented in Table-2. The highest benefit cost ratio was obtained in blackgram as compared to greengram during kharif under rain-fed conditions.

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(Received on 12-08-2002 and revised on 14-08-2003)

*The Andhra Agric.* J. **50** (3&4) : 207 - 210, 2003

# Evaluation of Nitrogen - Use - Efficiency of Different Rice Varieties Supplied with Organic and Inorganic Sources of Nitrogen

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## ABSTRACT

Alternative strategies studied for N fertilizer management to increase the N-use efficiency in lowland rice were studied in 2000-2001. A field experiment was conducted to evaluate the 50% N each through fertilizer and organic sources (FYM+GM) in comparison with the application of 100% N through inorganic source and no nitrogen application. Grain yield and N-use efficiency were higher with 50% N each through organic and inorganic source, and the variety NLR-T-145 showed significant superiority over other varieties viz. BPT 5204, MTU 2067 and MTU 4870.

**Key words :** Rice Varieties, Nitrogen use Efficiency, Sources of Nitrogen

Nitrogen is pivotal in yield realization of rice. In India about 67 per cent of rice soils are estimated to be in shortage of adequate N and consequently rice crop has become a major consumer of fertilizer nitrogen. The use effiency of applied fertilizer N by low land rice crop is ridiculously low, seldom touching 40 per cent which has been another cause of worry and challenge to the rice growers. Nitrogen use efficiency (NUE) usually ranges from 30 to 40% (Prasad and De Datta, 1979). Slow release N fertilizers are known to increase the NUE (Singh and Singh, 1994). Our objective was to evaluate the nitrogen use efficiency of different rice varieties supplied with organic and inorganic sources of nitrogen in achieving stable yields of traditional varieties in this fluctuating and unpredictable environment.

## MATERIAL AND METHODS

An experiment was conducted during *kharif* 2000 - 2001 at the Agricultural College farm, Bapatla. The soil was a sandy clay loam (Sand 38.3%, silt 24.7% and clay 37%) with pH 8.4, organic carbon 0.9%, and available nitrogen 222.6 kg ha$^{-1}$. Twenty-eight-day-old seedlings were transplanted in 3.9 x 1.8 m plots with a spacing of 20 x 10 cm. A randomized block design with three replications was used. Four rice varieties (MTU 2067 MTU 4870, BPT 5204 and NLR-T-145) were studied at four nitrogen source (no nitrogen, 50% nitrogen through fertilizer (urea) + 50% nitrogen through organic source (FYM + Green manure), 75% nitrogen through fertilizer (Urea) + 25% nitrogen through organic source (FYM + Green Manure) and 100% nitrogen through fertilizer (Urea). A uniform dose of 100 kg N, 60 kg $P_2O_5$ and 30 kg $K_2O$ ha$^{-1}$ was applied. Entire $P_2O_5$ and $K_2O$ was applied basally to all treatments duly taking into consideration of the phosphorus and potassium content of the two organic source, which were incorporated into the soil. Nitrogen was applied as per the treatments in three split doses of 50% basal and 25% each at active tillering and panicle initiation stages. Recommended agronomic

Table 1 : Grain yield (kg ha$^{-1}$), straw yield (kg ha$^{-1}$), Harvest index and Nitrogen Uptake (kg ha$^{-1}$) of rice as influenced by varieties and nitrogen sources.

| Treatments | Grain Yield (kg ha$^{-1}$) | Straw Yield (kg ha$^{-1}$) | Harvest Index (%) | Nitrogen uptake (kg ha$^{-1}$) |
|---|---|---|---|---|
| **Varieties :** | | | | |
| $V_1$ : MTU 2067 | 4262 | 5179 | 45.1 | 90.4 |
| $V_2$ : MTU 4870 | 4359 | 5237 | 45.4 | 91.2 |
| $V_3$ : BPT 5204 | 3513 | 4505 | 43.8 | 81.3 |
| $V_4$ : NLR -T 145 | 5188 | 5778 | 46.8 | 98.5 |
| **Nitrogen Sources :** | | | | |
| $N_0$ : NO Nitrogen application | 2364 | 3081 | 43.4 | 57.3 |
| $N_1$ : 50% nitrogen through fertilizer + 50% nitrogen through (FYM + green manure) | 5751 | 6590 | 46.6 | 105.8 |
| $N_2$ : 75% nitrogen through fertilizer + 25% nitrogen through (FYM + green manure) | 5214 | 6120 | 46.0 | 102.8 |
| $N_3$ : 100% nitrogen through fertilizer | 4594 | 5436 | 45.8 | 95.5 |
| SEm ± | 188 | 171 | 0.8 | 2.3 |
| CD (0.05) | 542 | 493 | 1.8 | 6.6 |
| **Interaction:** | | | | |
| Varieties X Nitrogen Source | NS | NS | NS | NS |

NS : Non-significant FYM : Farm yard manure

practices and plant protection measures were followed.

Ten randomly selected and labeled hills were used to record the data on yield and yield attributes. The standard laboratory methods were used to analyse the plant and soil samples.

Various parameters derived to study the nitrogen use efficiency in the present experiment. They are Agronomic Efficiency (AE) ie kg Yield / kg N applied; Apparent Recovery (AR) ie kg increase in N uptake / kg N applied; Physiological Efficiency (PE) - kg increase in yield / kg increase in N uptake; Nitrogen Harvest Index - N uptake in economic yield / N uptake in biological yield, expressed in percentage.

## RESULTS AND DISCUSSION

Grain yield and straw yield of rice were significantly influenced both by rice varieties and nitrogen sources. However, the interaction between varieties and nitrogen sources was not significant (Table 1).

Among the varieties the NLR -T-145 exhibited overall superiority to the other three varieties. However, MTU 2067 and MTU 4870 were comparable. Nitrogen applied at 50% N

Table 2 : Nitrogen use efficiency of rice as influenced by varieties and nitrogen sources.

| Treatments | Agronomic efficiency (kg ha$^{-1}$) | Apparent Recovery (%) | Physiological efficiency (%) | Nitrogen Harvest (%) Index |
|---|---|---|---|---|
| **Varieties :** | | | | |
| $V_1$ : MTU 2067 | 21.08 | 36.77 | 57.34 | 55.4 |
| $V_2$ : MTU 4870 | 22.16 | 37.66 | 58.84 | 58.5 |
| $V_3$ : BPT 5204 | 12.76 | 26.66 | 47.87 | 54.3 |
| $V_4$ : NLR -T -145 | 31.37 | 45.77 | 68.54 | 59.4 |
| **Nitrogen Sources :** | | | | |
| $N_1$ : 50% nitrogen through fertilizer + 50% nitrogen through (FYM + green manure) | 37.63 | 53.88 | 69.83 | 61.20 |
| $N_2$ 75% nitrogen through fertilizer + 25% nitrogen through (FYM + green manure) | 31.66 | 50.55 | 62.63 | 60.10 |
| $N_3$ : 100% nitrogen through fertilizer | 24.77 | 42.44 | 58.37 | 59.96 |

FYM : Farm yard manure

through inorganic and 50% N through organic sources resulted in the highest grain yield, which was however, comparable to the combination of 75% N through inorganic and 25% N through organic source, but was distinctly superior to 100% N supply through fertilizer. Similar results were observed in case of N uptake (Table 1). Supply of the required nutrients through organic and inorganic sources and biofertilizers facilitated balanced nutrition of the crop, which resulted in enhanced grain yield (Jayabal *et al.*, 1999). Increased uptake might be due to higher availability of nutrients from the soil reservoir and also from the added sources of organic manures.

Nitrogen - use - efficiency *viz.* agronomic efficiency, apparent recovery, physiological efficiency as influenced by both varietal character and nitrogen source, was the highest with NLR-T-145 while no appreciable difference was noticed between the varieties MTU 2067 and MTU 4870. This might be due to genetic variability in yields of rice genotypes (Thorat and Patil, 1987; Chander and Panday, 1996.)

Nitrogen supply at 50% N each through fertilizer and organic sources (FYM + GM) was instrumental in recording the highest value of nitrogen use efficiency, which was however similar to the combination of 75% N through fertilizer and 25% N through organic source (FYM + GM) (Table 2 and Figure 1).

The lowest value of nitrogen - use efficiency was observed with 100% N supply through inorganic source. The rate of N release in these treatments also probably matched well with the N requirement of rice, enabling the realization of higher grain yield as a result of greater efficiency. Better performance of rice under integrated nitrogen sources as exhibited

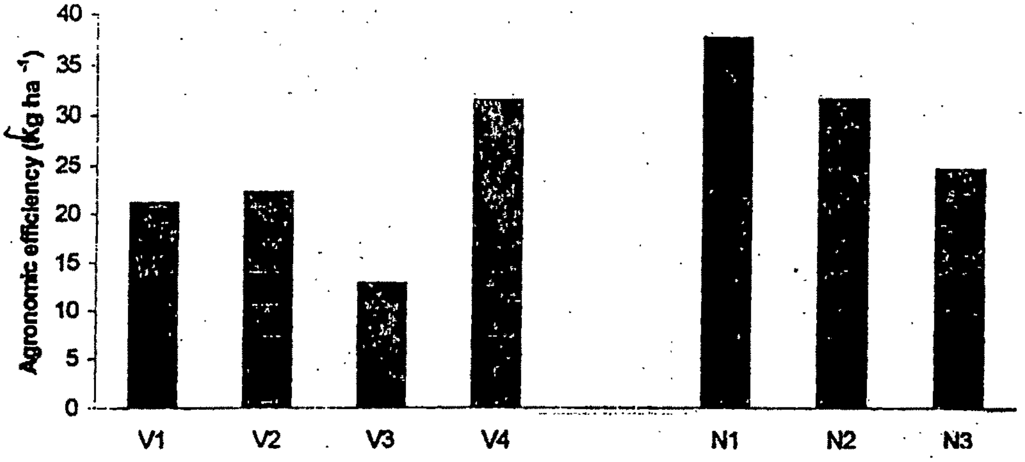

*Fig. 1 Agronomic Efficiency of Rice as Influenced by Varieties and Nitrogen Sources*

in the present study corroborates the findings of Sihag and Singh (1997)

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(Received on 26-04-2002 and revised on 19-06-2002)

*The Andhra Agric.* J. **50** (3&4) : 211 - 215, 2003

# Effect of Weed Management on Crop-Weed Competition, Grain Yield and Nutrient Uptake in Rice

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## ABSTRACT

A field trial was carried out on clayey loam soil during *kharif* 2000 at Rajendranagar, Hyderabad to investigate the effect of weed management on crop-weed competition and nutrient uptake (N,P and K) by transplanted rice at harvest. Eight herbicides viz. Butachlor, (Machete), Cinmethylin + 2,4-DEE (Argold), Flufenacet (Drado), Anilophos + Ethoxysulfuron (Rice guard),Acetochlor, pyrazosulfuron ethyl, Alkombo, Almix + Butachlor and Butachlor followed by Almix were evaluated along with hand weeding twice at 20 and 40 DAT and standard checks of unweeded and weed free treatments. Grasses were the predominant weeds in the experimental field. The investigation revealed that application of Rice guard (Anilophos + Ethoxysulfuron) @ 0.375 + 0.012 kg a.i. ha$^{-1}$ and Butachlor @ 1.5 kg a.i. ha-1 have recorded higher weed control efficiency, lower weed index values, significantly higher grain and straw yields over rest of the treatments but remained at par with hand weeding twice at 20 and 40 DAT. The nutrient uptake by crop was also significantly influenced by various treatments. Next to weed free treatment, Rice guard and Butachlor were significantly superior in recording higher nutrient (N,P & K) uptake by crop and were at par with two hand weedings at 20 and 40 DAT compared to rest of the treatments.

**Key words :** Weed Management, Crop-Weed Competition, Nutrient Uptake

Rice (*Oryza sativa L.*) the most important staple food crop of India, is cultivated over an area of 45.5 million hectares under different situations, wherein the weed species as well as the intensity differs. Weeds one of the most severe biological constraints for higher rice production competes for nutrients, water, solar energy and space at the expense of crop. Hence, the advantage of applied nutrients is seldom achieved by the crop as weeds remove considerable amount of nutrients from the crop fields. Further, with the spread of modern semi-dwarf varieties and increase in the fertilizer use for these high yielding varieties, has warranted the need for timely and suitable weed control. Weed growth is a serious problem under transplanted condition due to alternate flooding and drying resulting in a flush of both terrestrial and aquatic weeds and a yield loss ranging from 35 to 56 per cent (Jena and Mishra, 1992 and Chaudhary *et al.*, 1995). Scarcity of labour during peak periods and continuous rains many a times do not allow timely control of weeds by mannual method which is very labourious and costly. Under such situations chemical weed control is the best alternative practice. Hence, the present investigation was undertaken to find out the effect of weed management on crop-weed competition, grain yield and nutrient uptake of rice at harvest.

## MATERIAL AND METHODS

Investigation was undertaken at Rice Section, Agricultural Research Institute, Rajendranagar, Hyderabad during *Kharif* season of 2000. The experimental site was clayey loam with pH 8.2, medium in organic matter (0.54%), low in available nitrogen (279 kg ha$^{-1}$), medium in available phosphorus (30.6 kg ha$^{-1}$) and available potassium (235 kg ha$^{-1}$). The experiment was laid out in randomized block design with sixteen treatments and replicated twice. Eight herbicides viz. Butachlor @ 1.5 kg

Table 1 : Effect of weed management on crop weed competition and yield attributes of Rice at harvest.

| Treatment | Concentration (%) | Time of application (DAT) | Weed dry matter (gm$^{-2}$) | Weed control Efficiency (%) | Weed index (%) | Panicles (m$^{-2}$) | Grains / Panicle |
|---|---|---|---|---|---|---|---|
| Butachlor (Machete) @ 1.5 kg a.i.ha$^{-1}$ | 50 EC | 3-7 | 51.4 | 64.1 | 8.6 | 463 | 138 |
| Cinmethylin + 2,4-DEE (Argold) @ 0.375 kg a.i.ha$^{-1}$ | 50 EC | 7 | 76.6 | 46.5 | 25.8 | 426 | 97 |
| Cinmethylin + 2,4-DEE (Argold) @ 0.500 kg a.i.ha$^{-1}$ | 50 EC | 7 | 63.2 | 55.8 | 28.5 | 432 | 105 |
| Flufenacet (Drado) @ 0.09 kg a.i.ha$^{-1}$ | 60 WP | 3-5 | 86.3 | 39.7 | 20.0 | 428 | 98 |
| Flufenacet (Drado) @ 0.12 kg a.i.ha$^{-1}$ | 60 WP | 3-5 | 71.6 | 50.0 | 13.8 | 442 | 99 |
| Anilophos + Ethoxysulfuron (Rice guard) @ 0.312 + 0.012 kg a.i.ha$^{-1}$ | 25 + 1 WP | 10 | 46.5 | 67.5 | 7.1 | 485 | 150 |
| Acetochlor @ 0.100 kg a.i. ha$^{-1}$ | 90 EC | 3-7 | 78.2 | 45.3 | 19.3 | 435 | 105 |
| Acetochlor @ 0.150 kg a.i. ha$^{-1}$ | 90 EC | 3-7 | 63.7 | 55.5 | 13.5 | 442 | 121 |
| Pyrazosulfuron-ethyl @ 0.010 kg a.i. ha$^{-1}$ | 10 WP | 8 | 97.2 | 32.1 | 16.7 | 435 | 118 |
| Pyrazosulfuron-ethyl@0.015 kg a.i.ha$^{-1}$ | 10 WP | 8 | 69.2 | 51.6 | 12.5 | 450 | 134 |
| Alkombo @ 0.204 kg a.i. ha$^{-1}$ | 25.5 WP | 3 | 70.3 | 50.9 | 14.8 | 446 | 132 |
| Almix + Butachlor (Machete) @ 0.004 + 1.0 kg a.i. ha$^{-1}$ | 20 WP + 50 EC | 3 | 58.5 | 64.1 | 11.1 | 472 | 136 |
| Butachlor (Machete) fb Almix @ 0.004 + 1.0 kg a.i. ha$^{-1}$ | 50 EC fb20 WP | 3fb21-25 | 50.6 | 64.6 | 11.0 | 469 | 137 |
| Hand Weeding twice at 20 and 40 DAT | - | 20 and 40 | 32.8 | 77.0 | 5.9 | 490 | 164 |
| Unweeded check | - | - | 143.2 | - | 35.5 | 325 | 92 |
| Weed free check | - | - | 0.0 | 100.0 | - | 510 | 177 |
| S.Em ± | - | - | 1.7 | - | - | 8 | 5 |
| CD (P=0.05) | - | - | 5.1 | - | - | 24 | 15 |

a.i. ha$^{-1}$, cinmethylin + 2,4 DEE @ 0.375 kg a.i. ha$^{-1}$; cinmethylin + 2,4 DEE @ 0.500 kg a.i. ha$^{-1}$, Flufenacet @ 0.09 kg a.i.ha$^{-1}$, Flufenacet @ 0.12 kg a.i. ha$^{-1}$, Anilophos + Ethoxysulfuron @ 0.312 + 0.012 kg a.i. ha$^{-1}$, Acetochlor @ 0.100 kg a.i. ha$^{-1}$, Acetochlor @ 0.150 kg a.i. ha$^{-1}$, Pyrazosulfuron - ethyl @ 0.010 kg a.i. ha$^{-1}$, Pyrazosulfuron - ethyl @ 0.015 kg a.i. ha$^{-1}$, Alkombo @ 0.204 kg a.i. ha$^{-1}$, Almix + Butachlor @ 0.004 + 1.0 kg a.i. ha$^{-1}$, Butachlor followed by Almix @ 1.0 fb 0.004 kg a.i. ha$^{-1}$ were evaluated against two hand weedings at 20 and 40 DAT, unweeded check and weed free check where 6 weedings were done upto 90 DAT. All the

Table 2 : Effect of weed management on Rice yield and nutrient uptake at harvest.

| Treatment | Concentration (%) | Time of application (DAT) | Grain yield (t ha$^{-1}$) | Straw yield (t ha$^{-1}$) | Nutrient uptake at harvest by crop (kg ha$^{-1}$) (Nitrogen) | |
|---|---|---|---|---|---|---|
| | | | | | Grain | Straw |
| Butachlor (Machete) @ 1.5 kg a.i.ha$^{-1}$ | 50 EC | 3-7 | 4.7 | 5.8 | 53.4 | 25.7 |
| Cinmethylin + 2,4-DEE (Argold) @ 0.375 kg a.i.ha$^{-1}$ | 50 EC | 7 | 3.8 | 5.2 | 43.3 | 22.5 |
| Cinmethylin + 2,4-DEE (Argold) @ 0.500 kg a.i.ha$^{-1}$ | 50 EC | 7 | 3.7 | 5.0 | 41.8 | 21.5 |
| Flufenacet (Drado) @ 0.09 kg a.i.ha$^{-1}$ | 60 WP | 3-5 | 4.1 | 5.6 | 46.6 | 24.0 |
| Flufenacet (Drado) @ 0.12 kg a.i.ha$^{-1}$ | 60 WP | 3-5 | 4.4 | 5.6 | 50.5 | 25.8 |
| Anilophos + Ethoxysulfuron (Rice guard) @ 0.312 + 0.012 kg a.i.ha$^{-1}$ | 25 + 1 WP | 10 | 4.8 | 5.9 | 54.6 | 24.1 |
| Acetochlor @ 0.100 kg a.i. ha$^{-1}$ | 90 EC | 3-7 | 4.1 | 5.5 | 47.1 | 23.8 |
| Acetochlor @ 0.150 kg a.i. ha$^{-1}$ | 90 EC | 3-7 | 4.4 | 5.8 | 50.6 | 25.1 |
| Pyrazosulfuron-ethyl @ 0.010 kg a.i. ha$^{-1}$ | 10 WP | 8 | 4.3 | 5.4 | 49.0 | 23.7 |
| Pyrazosulfuron-ethyl@0.015 kg a.i.ha$^{-1}$ | 10 WP | 8 | 4.5 | 5.2 | 51.1 | 23.3 |
| Alkombo @ 0.204 kg a.i. ha$^{-1}$ | 25.5 WP | 3 | 4.4 | 5.7 | 49.6 | 24.5 |
| Almix + Butachlor (Machete) @ 0.004 + 1.0 kg a.i. ha$^{-1}$ | 20 WP + 50 EC | 3 | 4.6 | 5.5 | 51.7 | 23.7 |
| Butachlor (Machete) fb Almix @ 1.0 fb 0.004 kg a.i. ha$^{-1}$ | 50 EC fb20 WP | 3fb21-25 | 4.6 | 5.3 | 51.9 | 22.9 |
| Hand Weeding twice at 20 and 40 DAT | - | 20 and 40 | 4.8 | 5.9 | 55.9 | 25.2 |
| Unweeded check | - | - | 3.0 | 4.2 | 33.6 | 18.0 |
| Weed free check | - | - | 5.1 | 6.2 | 60.7 | 27.7 |
| S.Em ± | - | - | 0.6 | 0.3 | 0.8 | 0.1 |
| CD (P=0.05) | - | - | 1.2 | 0.9 | 2.4 | 0.3 |

herbicides were sprayed as per the treatments (Table 1) by mixing in water @ 500 L ha$^{-1}$ using a hand sprayer with flat pan nozzle. Thirty days old Rice Seedlings cv. Satya (RNR - 1446) were transplanted on I$^{st}$ August 2000 with a spacing of 20 x 10 cm and received a uniform dose of 120 kg N, 60 kg $P_2O_5$, 40 kg $K_2O$ and 50 kg $ZnSO_4$. Entire $P_2O_5$, $ZnSO_4$ along with 1/ 3$^{rd}$ N and 3/4 $^{th}$ $K_2O$ was applied basally while the rest of the nitrogen was applied in two equal splits, i.e. at active tillering and panicle initiation stages respectively. $K_2O$ was applied at panicle initiation alone. Weeds from the quadrat area were removed at 30 days interval. The weeds were first sun dried followed by oven drying to a constant weight at 80$^0$C. The resultant dry matter was expressed in gm$^{-2}$. Five crop samples were collected randomly at 30 days interval for dry matter computation and the samples at harvest were analysed for nutrient uptake (N,P&K). Nitrogen, phosphorus and potassium content of the samples was estimated by modified microkjeldahl, molybdo phosphoric yellow colour and flame photometer methods respectively and subsequently the uptake per hectare was computed both in grain and straw. Irrigation water was maintained upto 2 cm until establishment of the seedlings and later upto 5 ± 2 cm until physiological maturity (irrigation once in 2 days), later drained off before harvest of the crop.

Table 3 : Effect of weed management on nutrient uptake at harvest.

| Treatment | Concentration (%) | Time of application (DAT) | Nutrient uptake at harvest by crop (kg ha$^{-1}$) (Phosphorus) |  | Nutrient uptake at harvest by crop (kg ha$^{-1}$) (Potassium) |  |
|---|---|---|---|---|---|---|
|  |  |  | Grain | Straw | Grain | Straw |
| Butachlor (Machete) @ 1.5 kg a.i.ha$^{-1}$ | 50 EC | 3-7 | 12.5 | 6.6 | 11.7 | 53.6 |
| Cinmethylin + 2,4-DEE (Argold) @ 0.375 kg a.i.ha$^{-1}$ | 50 EC | 7 | 8.8 | 5.6 | 9.4 | 46.0 |
| Cinmethylin + 2,4-DEE (Argold) @ 0.500 kg a.i.ha$^{-1}$ | 50 EC | 7 | 8.4 | 5.4 | 8.5 | 44.8 |
| Flufenacet (Drado) @ 0.09 kg a.i.ha$^{-1}$ | 60 WP | 3-5 | 9.7 | 6.0 | 9.9 | 52.2 |
| Flufenacet (Drado) @ 0.12 kg a.i.ha$^{-1}$ | 60 WP | 3-5 | 11.0 | 6.8 | 11.1 | 54.7 |
| Anilophos + Ethoxysulfuron (Rice guard) @ 0.312 + 0.012 kg a.i.ha$^{-1}$ | 25 + 1 WP | 10 | 12.8 | 6.1 | 12.7 | 47.7 |
| Acetochlor @ 0.100 kg a.i. ha$^{-1}$ | 90 EC | 3-7 | 9.8 | 5.7 | 10.4 | 48.1 |
| Acetochlor @ 0.150 kg a.i. ha$^{-1}$ | 90 EC | 3-7 | 11.2 | 6.1 | 11.2 | 52.7 |
| Pyrazosulfuron-ethyl @ 0.010 kg a.i. ha$^{-1}$ | 10 WP | 8 | 10.5 | 5.9 | 10.6 | 47.2 |
| Pyrazosulfuron-ethyl@0.015 kg a.i.ha$^{-1}$ | 10 WP | 8 | 10.8 | 5.5 | 11.3 | 47.0 |
| Alkombo @ 0.204 kg a.i. ha$^{-1}$ | 25.5 WP | 3 | 10.7 | 6.2 | 10.6 | 52.0 |
| Almix + Butachlor (Machete) @ 0.004 + 1.0 kg a.i. ha$^{-1}$ | 20 WP + 50 EC | 3 | 11.0 | 5.9 | 11.3 | 46.9 |
| Butachlor (Machete) fb Almix @ 1.0 fb 0.004 kg a.i. ha$^{-1}$ | 50 EC fb20 WP | 3fb21-25 | 10.8 | 5.8 | 11.8 | 44.7 |
| Hand Weeding twice at 20 and 40 DAT | - | 20 and 40 | 13.1 | 6.7 | 15.8 | 52.3 |
| Unweeded check | - | - | 5.7 | 3.7 | 6.9 | 29.0 |
| Weed free check | - | - | 15.6 | 7.9 | 21.7 | 61.8 |
| S.Em ± | - | - | 0.2 | 0.1 | 0.2 | 1.6 |
| CD (P=0.05) | - | - | 0.7 | 0.3 | 0.7 | 4.7 |

The major weed species found in the experimental field were *Echinochloa colona* Link., *Panicum repens* Linn., *Paspalum distichum* L., *cynodon dactylon* pers., among grasses, *cyperus difformis L., Cyperus iria L., Scirpus supinus Linn., Fimbrystylis dichotom, Vahl.*, among sedges and *Caesulia axillaris* Roxb., *Eclipta alba, Ammania baccifera Koehme.*, and *Marsilia minuta* among broad leaved weeds.

## RESULTS AND DISCUSSION

Weed dry weight at harvest was significantly lower with 2 hand weedings at 20 and 40 DAT. Among the herbicide treatments Anilophos + Ethoxysulfuron, Butachlor fb Almix and Butachlor alone effectively controlled the weed growth over rest of the treatments. The results are in accordance with the findings of Joy *et al.* (1991), Mukherjee and Bhattacharya (1999), Bhowmick *et al.* (2000).

Similarly higher weed control efficiency and lower weed index values were recorded by hand weeding twice followed by Aniolophos + Ethoxysulfuron, Butachlor and Butachlor + Almix applied plots, which showed the effectiveness of these herbicidal treatments in controlling weeds over rest of the treatments.

Similar results were reported by Dhiman *et al.*, (1998). Gogoi (1998) Mukherjee and Bhattacharya (1999) and Nandal *et al.*, (1999) Bhowmick *et al.*, (2000) which might be due to the effective control of wide range of weed species sedges, grasses, broad leaved weeds and aquatic weeds by herbicide mixtures.

Weed control either by herbicides i.e. Rice guard, Almix + Butachlor, Butachlor fb Almix and Butachlor alone or by two hand weedings showed significant influence on yield components namely number of panicles / m$^2$ and number of grains/ panicle over unweeded check. This was mainly due to the better control of weeds in the above treatments which reduced crop weed competition and made more nutrients, space, light and other growth factors available to the crop thus enhancing grain yield (Kolhe *et al.*, 1988).

Significant variation in grain and straw yield was observed due to different treatments. Adoption of two hand weedings at 20 and 40 DAT, application of Rice guard and Butachlor brought about significant yield advantage of 60.1, 58.2 and 55.5 per cent respectively over unweeded check which is due to increased crop-weed competition owing to the high weed density, dry matter accumulation and nutrient uptake by weeds thus reducing the yield attributes and nutrient uptake by crop. Yield loss to an extent of 35.5% was recorded in this treatment. These results are in consistent with those reported by Gautam and Mishra (1995) and Phogat and Pandey (1998). Weed control treatments significantly affected the nutrient uptake by crop over unweeded check (Table 2).

Hand weeding twice at 20 and 40 DAT recorded highest the nutrient uptake by grain and straw followed by Rice guard and Flufenacet treated plots.

This is due to the significant and negative correlation between yield and dry weight of weeds (Kolhe *et al.*, 1988 and Bali *et al.*,1994).

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(Received on 28-04-2002 and revised on 24-05-2003)

*The Andhra Agric.* J. **50** (3&4) : 216 - 218, 2003

# Performance of Rice in Ill-Drained Conditions at Different Levels and Sources of Nitrogen

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## ABSTRACT

Different combinations of sources and levels of nitrogen for ill drained rice were tested. The study revealed that application of nitrogen through Di ammonium phosphate was superior and recorded higher growth and yield parameters. Among the different levels, application of 200 kg N ha$^{-1}$ in three splits was found beneficial for rice under ill - drained conditions.

**Key words :** Nitrogen management, ill - drained conditions, sandy clay loam, diammonium phosphate

Rice crop cultivated under puddled conditions is subjectd to ill-drained environment due to the bad drainage condition and excess rain during the crop growth. Management of rice under such ill-drained conditions has to be viewed in terms of higher production. Among the various production factors, fertilizer management is very crucial. The farmers are using various forms of fertilizers being available in the market without knowing the crops response to the applied fertilizer. An other important aspect of nitrogen management for rice is the optimum dose. Dose of nitrogen depends upon several factors like rice variety, season, the form of fertilizer and other environment factors we maintain for the rice crop. Hence, an experiment was conducted to know the best form of fertilizer along with the correct dose to get the best production under ill-drained conditions during *kharif* season.

## MATERIALS AND METHODS

An experiment was conducted in an ill-drained sandy clay loam soil of the Agricultural College Farm, Bapatla during *kharif* 2000. Four sources of nitrogen ($S_1$-Urea, $S_2$-Calcium Ammonium Nitrate, $S_3$-Urea Ammonium Phosphate and $S_4$-Di ammonium Phosphate) in main plot treatments and four levels of nitrogen ($F_1$-80 kg N ha$^{-1}$, $F_2$-120 kg N ha$^{-1}$, $F_3$-160 kg N ha$^{-1}$, F4-200 kg N ha$^{-1}$) in sub-plot treatments were taken in a split-plot design with three replications (Table 1). The soil of the experiment was having a pH of 7.9, low in nitrogen content, low in phosphorus content and high in potassium content.

## RESULTS AND DISCUSSION

There was a significant increase in the plant height from 80-200 kg N ha$^{-1}$ at all stages except at 60 DAT where 80 kg N ha$^{-1}$ and 120 kg N ha$^{-1}$ were a par. The rapid growth with higher nitrogen level was caused by the maintenance of adequate and continuous nitrogen supply to the plant (Singh and Singh, 1999). Increase in the shoot growth with the increasing levels of nitrogen in ill-drained conditions was also reported by Shen *et al.* (1997). Significantly taller plants were observed in urea, urea ammonium phosphate (UAP) and di ammonium phosphate (DAP) applied plots over (Calcium Ammonia

Table 1 : Plant height (cm), number of tillers and Dry matter accumulation ($gm^{-2}$) of rice as influenced by different sources and levels of nitrogen under ill-drained conditions.

| Treatments | Plant height (cm) | | No. of tillers | | Dry matter accumulation ($gm^{-2}$) | |
|---|---|---|---|---|---|---|
| Sources of N | 60 DAT | Maturity | 60 DAT | Maturity | 60 DAT | Maturity |
| $S_1$ | 79.5 | 96.8 | 362.0 | 458.0 | 479.1 | 1207.0 |
| $S_2$ | 67.6 | 83.0 | 302.0 | 383.0 | 400.7 | 1001.8 |
| $S_3$ | 81.6 | 98.9 | 370.0 | 468.0 | 492.0 | 1230.0 |
| $S_4$ | 85.6 | 106.6 | 373.0 | 473.0 | 497.3 | 1243.2 |
| SEM + | 2.3 | 3.9 | 14.0 | 16.7 | 17.6 | 41.9 |
| CD (P = 0.05) | 8.2 | 13.7 | 48.5 | 57.9 | 60.8 | 144.7 |
| CV (%) | 10.2 | 14.2 | 13.8 | 13.03 | 13.0 | 12.4 |
| Levels of N (kg $ha^{-1}$) | | | | | | |
| $F_1$ | 69.2 | 84.4 | 302.0 | 382.0 | 400.1 | 1001.1 |
| $F_2$ | 74.0 | 92.9 | 333.0 | 421.0 | 442.1 | 1113.5 |
| $F_3$ | 80.5 | 101.8 | 357.0 | 452.0 | 474.6 | 1186.5 |
| $F_4$ | 90.4 | 111.8 | 415.0 | 526.0 | 552.4 | 1381.0 |
| SEM + | 2.2 | 2.9 | 11.8 | 15.0 | 16.0 | 40.8 |
| CD (P = 0.05) | 6.4 | 8.4 | 34.4 | 43.8 | 46.3 | 119.1 |
| CV (%) | 9.7 | 10.3 | 11.6 | 11.7 | 11.8 | 12.0 |

Nitrate) CAN at all stages of crop growth. Similar results were also reported by Patel *et al.* (1990). The lower plant height in CAN applied plots might be due to the more loss of nitrogen under water logged conditions (Shen *et al., 1997*).

Different sources of nitrogen like diammonium phosphate, UAP and Urea produced significantly more number of tillers per $m^2$ over CAN and were at par with each other at all stages of crop growth and these results were supported by Zia *et al.* (1992). Application of 200 kg N $ha^{-1}$ produced highest number of tillers. There was no significant difference between 80 and 120 and 120 and 160 kg $Nha^{-1}$. This might be due to the increased availability of nitrogen at higher levels (Yoshida, 1981) and similar results were reported by Singh and Singh (1999). At higher nitrogen rates, tiller death was more due to the over crowding of tillers resulting in severe intrahill competition for nutrients, light and there by the death of tillers.

Among the different sources of nitrogen diammonium phosphate, urea ammonium phosphate and Urea were superior over CAN with regard to dry matter accumulation. Dry matter accumulation is the product of plant height and number of tillers (Bose, 1995). In diammonium phosphate applied plots, more dry matter production was due to the more number of tillers. CAN application resulted in the lower dry matter production than the Urea due to more loss of nitrogen under water logged conditions (Sharma *et al.*, 1993). Application of 200 kg N $ha^{-1}$ produced significantly higher dry matter production because it is the outcome of growth, photosynthetic activity of the plant and their capacity to utilize the available nutrients. Increased nitrogen supply could increase the formation of protein hence growth sites and sites of assimilates and thus dry matter production (Singh, 1997). The higher dry matter production at the higher levels of nitrogen might be because of the more taller plants, more number of sturdy tillers produced at all stages of

Table 2 : Grain yield (t ha⁻¹), Straw yield (t ha⁻¹) and harvest index of rice as influenced by different sources and levels of nitrogen under ill-drained conditions

| Treatments | Grain yield (t ha⁻¹) | Straw yield (t ha⁻¹) | Harvest index |
|---|---|---|---|
| Sources of N | | | |
| $S_1$ | 4.82 | 5.48 | 46.8 |
| $S_2$ | 4.29 | 6.20 | 40.8 |
| $S_3$ | 5.21 | 6.73 | 43.6 |
| $S_4$ | 5.46 | 7.50 | 42.1 |
| SEM | 0.18 | 0.35 | 2.0 |
| CD (P = 0.05) | 0.53 | 1.21 | NS |
| CV (%) | 12.8 | 18.7 | 18.0 |
| Levels of N (kg ha⁻¹) | | | |
| $F_1$ | 4.49 | 5.70 | 43.7 |
| $F_2$ | 4.70 | 5.77 | 45.2 |
| $F_3$ | 4.99 | 6.98 | 41.7 |
| $F_4$ | 5.79 | 7.47 | 43.6 |
| SEM | 0.14 | 0.43 | 1.0 |
| CD (P = 0.05) | 0.50 | 1.27 | 3.0 |
| CV (%) | 10.30 | 13.25 | 8.6 |

crop growth resulting in more dry matter production which is the function of plant height and number of tillers (Table 2).

Application of nitrogen through diammonium phosphate resulted in significantly higher grain and straw yields over rest of the sources, whereas, the harvest index was uninfluenced by the nitrogen sources. When 200 kg N ha⁻¹ was applied, highest grain and straw yield were observed. Similar reports of higher yields with high nitrogen rates was also given by Singh and Singh (1999).

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(Received on 04-01-2003 and revised on 29-11-2003)

*The Andhra Agric. J.* **50** (3&4) : 219 - 221, 2003

# Effect of P Sources and Methods of Application on Phosphorus Use Efficiency of Irrigated Groundnut

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## ABSTRACT

A field trail was conducted on sandy loam soils during *rabi* 2001 to study the phosphorus use efficiency of groundnut through different sources and methods of application. Application of 75% of recommended phosphorus as basal to soil and the remaining 25% through Monoammonium phosphate as foliar spray at 30 and 60 DAS along with PSB inoculation resulted in significantly higher dry matter production, pod yield and phosphorus use efficiency.

**Key words :** Groundnut, Phosphorus use efficiency, Foliar spray.

In India, groundnut is grown in an area of 7.4 m.ha producing 8.4 m.t. with an average productivity of 1135 kg ha$^{-1}$ (Directorate of Economics and Statistics, 2000). In its varied response to added fertilizers, fluctuations in productivity levels for the last two decades, the peanut has been appropriately referred to as the "unpredictable legume". Agronomic research carried out in India for evolving better package of practices for groundnut was substantial with lion's share diverted to its nutrient management. But, very little attention has been paid to the post flowering manipulation of crop nutrition. The efficiency of phosphatic fertilizer utilization by crop plants is also low owing to the fixation of applied phosphates within a very short period. Groundnut absorbs 40-50% of the total nutrient only between reproductive to maturity phase (Loganathan and Krishnamoorthy, 1977). Plant roots may become inactive at later stages of crop growth and nutrient absorption in required quantities is very poor. Researchers have hypothesized that foliar fertilization can minimize nutrient depletion from leaves during seed development leading to higher leaf photosynthesis (Boote *et al.*, 1978). Provision of nutrients during this phase in addition to the regular soil application may go a long way to increase the groundnut productivity. Keeping this in view, the present investigation was taken up to study the influence of sources and method of application on phosphorus use efficiency (PUE) of groundnut.

## MATERIAL AND METHODS

A field trail was conducted during *rabi*, 2001 at Agricultural College Farm, Bapatla on sandy loam with low available nitrogen, medium available phosphorus and high available potassium. Eight treatments were tested in randomized block design, replicated thrice. Spanish bunch (TMV 2) groundnut was sown on November 21, 2001 adopting 30 x 10 cm spacing. Nitrogen was applied basally as a single dose through urea with *rhizobium* inoculation to all the treatments duly taking into consideration of the nitrogen content of monoammonium phosphate (MAP) to be added as foliar spray. Potassium was applied through Murate of potash as per the recommendation (recommended dose N : P : K

30 : 40 : 50 Kg ha$^{-1}$) - phosphorus was applied as per the treatment *viz.*, Single super phosphate as basal and MAP (12 : 61 : 0 - N : P : K) applied as foliar spray @ 0.5 % concentration through power sprayer. Altogether, eight irrigations were given during the crop period. The weekly mean maximum and minimum temperatures ranged from 27.8°C to 32.2°C and 16.2°C to 22.5°C respectively. Adequate and timely plant protection measures were taken up against pest and diseases. PUE was calculated by the formula.

$$\text{Phosphorus use efficiency (kg grain / kg } P_2O_5 \text{ applied)} = \frac{\text{Yield in P applied plot - Yield in control plot}}{\text{Phosphorus applied in kgs.}}$$

Treatments :

$T_1$ - No phosphorus ($P_0$)

$T_2$ - 100% phosphorus as basal ($FP_{100}$)

$T_3$ - 100% phosphorus as basal and seed inoculation with phosphorus solubilizing bacteria ($FP_{100}$+PSB)

$T_4$ - 75% phosphorus as basal and seed inoculation with phosphorus solubilizing bacteria ($FP_{75}$+PSB)

$T_5$ - 75% phosphorus as basal and 25% phosphorus through monoammonium phosphate as foliar spray at 30 days after sowing $FP_{75}+MAP_{25}$ (30 DAS)

$T_6$ - 75% phosphorus as basal and 25% phosphorus through monoammonium phosphate as foliar spray at 30 and 60 days after sowing $FP_{75}+MAP_{25}$ (30 and 60 DAS)

$T_7$ - 75% phosphorus as basal and 25% phosphorus through monoammonium phosphate as foliar spray at 30 days after sowing and seed inoculation with phosphorus solubilizing bacteria $FP_{75}+MAP_{25}$ (30DAS) + PSB

$T_8$ - 75% phosphorus as basal and 25% phosphorus through monoammonium phosphate as foliar spray at 30 and 60 days after sowing and seed inoculation with phosphorus solubilizing bacteria $FP_{75}+MAP_{25}$ (30 and 60 DAS) + PSB

## RESULTS AND DISCUSSION

### Effect on crop growth

Application of phosphorus at 75% as basal and 25% as foliar spray through MAP at 30 and 60 DAS along with PSB inoculation (T8) recorded significantly higher growth characters *viz.*, root dry weight and dry matter production. However, $FP_{75}$ + $MAP_{25}$ (30 and 60 DAS) + PSB ($T_8$) was on a par with $FP_{75}$ + $MAP_{25}$ 30 DAS + PSB ($T_7$) (Table 1). The effective blending of soil and foliar application of phosphorus associated with seed inoculation of PSB has resulted in a favourable environment for P nutrition. This might have resulted in greater root surface area for the formation of more number of nodules besides increased nodule weight as well as increased root dry weight. The superiority of the integrated supply can be attributed to the active involvement of phosphorus in carbohydrate metabolism that rendered increased vegetative growth confirming phosphorus involvement in the formation of starch and cellulose and also foliar application resulting in adequate supply of phosphorus to the foliage during the stage of peak requirement by the crop.

### Effect on Pod and Haulm yield :

Integrated supply of phosphorus through soil, foliar and PSB inoculation ($T_8$), recorded

Table : Growth characters, yield and PUE as influenced by treatments.

| Treatments | Root dry weight (g plant-1) at 60 DAS | Dry matter production (g $m^{-2}$) | Haulm yield (kg $ha^{-1}$) | Pod yield (kg $ha^{-1}$) | PUE |
|---|---|---|---|---|---|
| $P_0$ | 0.82 | 415.2 | 2333 | 1408 | -- |
| $FP_{100}$ | 2.32 | 526.3 | 2765 | 1802 | 9.9 |
| $FP_{100}$+PSB | 2.48 | 543.2 | 2923 | 1876 | 11.8 |
| $FP_{75}$+PSB | 2.30 | 520.3 | 2725 | 1710 | 10.1 |
| $FP_{75}$+$MAP_{25}$ (30 DAS) | 2.51 | 545.6 | 2973 | 1965 | 14.0 |
| $FP_{75}$+$MAP_{25}$ (30 & 60 DAS) | 2.39 | 552.4 | 2997 | 2005 | 15.0 |
| $FP_{75}$+$MAP_{25}$ (30 DAS) + PSB | 2.76 | 577.4 | 3262 | 2243 | 21.0 |
| $FP_{75}$+$MAP_{25}$ (30 & 60 DAS) + PSB | 2.82 | 588.6 | 3316 | 2276 | 21.7 |
| SEm± | 0.08 | 24.0 | 81 | 77.8 | -- |
| CD (P = 0.05) | 0.24 | 7.9 | 245 | 235 | -- |

higher pod and haulm yield (Table 1). The superior performance of groundnut under this treatment was due to increased leaf area producing more photosynthates besides synthesis of more carbohydrates, proteins and fats resulting in efficient partitioning, adequate and continuous supply of P through out the growth period. The superiority of foliar nutrition might be due to coincidence of foliar application with peak nutrient requirements of the crop, in supplementation to soil application. The quantity of nutrients absorbed by roots at peak period of nutrient requirement may not be sufficient to meet the needs at pod development stage (Boote *et al.*, 1978; Surendranath Reddy *et al.*, 1991; Samui and Minajur Ahasan, 1997; Shinde *et al.*, 2000).

**Effect on phosphorus use efficiency (PUE) :**

The maximum PUE was recorded with the integrated supply of P at 75% through soil and 25% P through MAP as foliar spray at 30 and 60 DAS along with PSB inoculation. The high PUE can be attributed to the integration of P fertilizers and biofertilizers associated with foliar application of MAP resulting in gradual and continuous availability of both N and P through *Rhizobium* and PSB respectively (Table 1).

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(Received on 07-07-2003 and revised on 19-09-2003)

*The Andhra Agric.* J. **50** (3&4) : 222 - 226, 2003

# Combining Ability of Sterility Mosaic Resistant Lines in Pigeonpea

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## ABSTRACT

Pre-ponderance of non-additive gene action was noticed for grain yield, days to 50 per cent flowering and maturity, plant height, primary and secondary branches, pods per plant and 100-seed weight. However, for seeds per pod, both additive and non-additive gene actions were important. ICP MS 288, resistant to sterility mosaic (SM) disease was good combiner for early maturity and short-stature. ICP MS 3783, tolerant to SM was better combiner for seed yield, pods per plant, 100-seed weight, primary and secondary branches. Among the males, LRG 30, showed good general combining ability for seed yield and majority of yield components. The sterility mosaic resistant parents, in general, were poor combiners for yield and majority of yield components.

**Key words :** Combining Ability, Mosaic Resistant, Pigeonpea.

Sterility mosaic (SM) is the most important disease of pigeonpea in the Indian sub-continent with no satisfactory chemical or cultural control (Reddy *et al.,* 1990). Breeding for resistance is therefore, considered the most effective and economic method of reducing yield losses (Stakman and Harrar, 1957).

Application of line x tester mating design (Kempthorne, 1957) was suggested for pigeonpea (Wallis *et al.,* 1981) to obtain information on combining ability for the lines for traits of economic importance. With the existence of male sterility (Wallis *et al.,* 1981) and a considerable degree of natural out-crossing (Green *et al.,* 1979) in pigeonpea, it is now possible to evaluate large number of lines for their combining ability. The present investigation was therefore undertaken to obtain information on combining ability of pigeonpea lines (resistant, tolerant and susceptible to SM) with regards to grain yield and its components.

## MATERIAL AND METHODS

The experimental material consisted of two male steriles (ICP MS 288 (resistant) and ICP MS 3783 (tolerant)) and 11 pollen parents (ICP 7035, ICP 7349, ICP 8006, ICP 8136 and ICP 8850 (resistant i.e., no apparent symptoms of SM), ICP 2376, ICP 7994 and ICP 11251 (tolerant i.e., ring spot symptoms of SM), BDN 1, LRG 30 and ICP 8863 (susceptible i.e., severe mosaic symptoms) (Table 1). The resistant and tolerant parents were sown in four sets at an interval of 15 days in 30 cm pots beside the infector-hedge, while the susceptible parent was raised under disease-free conditions. The confirmed resistant and tolerant plants were crossed in a line x tester mating during 1993 rainy season. The 13 parents and 22 hybrids were evaluated in a randomized block design with three replications at ICRISAT Asia Center, Patancheru, Andhra Pradesh, during 1994 rainy season, under disease-free conditions. Each

Table 1 : Description of parental lines

| Line | Reaction to SM | Maturity group | Growth habit |
|---|---|---|---|
| ICP MS 288 | Resistant | Early | Indeterminate and compact |
| ICP MS 3783 | Tolerant | Mid-late | Indeterminate and semi-spreading |
| ICP 2376 | Tolerant | Medium | Indeterminate and semi-spreading |
| ICP 7035 | Resistant | Mid-late | Indeterminate and semi-spreading |
| ICP 7349 | Resistant | Medium | Indeterminate and semi-spreading |
| ICP 7994 | Tolerant | Late | Indeterminate and semi-spreading |
| ICP 8006 | Resistant | Late | Indeterminate and compact |
| ICP 8136 | Resistant | Late | Indeterminate and compact |
| ICP 8850 | Resistant | Medium | Indeterminate and semi-spreading |
| ICP 8863 | Susceptible | Medium | Indeterminate and semi-spreading |
| ICP 11251 | Tolerant | Medium | Indeterminate and semi-spreading |
| BDN 1 | Susceptible | Medium | Indeterminate and semi-spreading |
| LRG 30 | Susceptible | Medium | Indeterminate and semi-spreading |

plot consisted of a single row of 4 m length. A spacing of 75 x 20 cm was adopted. Recommended packages were adopted. Observations on 10 randomly selected plants/ plot were recorded for plant height, primary branches, secondary branches, pods per plant, seeds per pod, 100-seed weight and seed yield. The plot means were used for statistical analysis. Days to flower and maturity were recorded on plot basis. The combining ability analysis was done as per Kempthorne (1975).

## RESULTS AND DISCUSSION

The analysis of variance, estimates of general combining ability (*gca*) and specific combining ability (*sca*) variances and their ratios for seed yield and yield components are presented in Table 2. Significant differences were observed amongst genotypes, parents and hybrids for all the characters. The parent vs hybrid comparison were also significant indicating heterotic effects for seed yield and yield components. The partitioning of hybrid sum of squares revealed that variances due to males and females were significant for all traits (except seed per pod for females). The interaction of females with males was significant for all characters, except, days to 50 per cent flowering and number of seeds per pod. Pre-dominant non-additive gene action was observed for all traits except for seeds per pod, wherein both additive and nonadditive gene actions were important. Population improvement program as proposed earlier by Laxman Singh and Pandey (1974); Dahiya and Brar (1997) and Patel *et al.* (1992) is suggested for exploitation of the nonadditive gene effects for improvement of seed yield and its components.

The resistant parents viz., ICP MS 288 and ICP 8850 with significant negative *gca* estimates (Table 3) may impart earliness and short stature to their progenies as reported by Omanga (1984) and Gupta *et al.* (1983). However, undesirable *gca* effects were noticed for the parent (ICP MS 288) with regards to seed yield, number of pods per plant and number of primary and secondary branches, in the present study. In contrast, the tolerant parent, ICP MS 3783 and the susceptible parents, LRG 30 and BDN 1 had positive and significant *gca* effects, and hence, desirable genes for seed yield, pods per plant and number of secondary branches. ICP MS 3783 ( a derivative of MS 3 A, reported

Table 2 : Analysis of variance for yield and yield components of parents and crosses in pigeonpea.

| Source | df | Days to 50 per cent flowering | Days to maturity | Plant height (cm) | Primary branches per plant | Secondary branches per plant | Pods per plant | Seeds per pod | 100-seed weight (g) | Seed yield per plant (g) |
|---|---|---|---|---|---|---|---|---|---|---|
| Replications | 2 | 1.56 | 3.06 | 12.16 | 4.41 | 7.29 | 8.27 | 0.11** | 0.21 | 46.58 |
| Genotypes | 34 | 12.43 ** | 29.42 ** | 581.85 ** | 39.87 ** | 35.20 ** | 1671.79 ** | 0.03 ** | 13.00 ** | 831.92 ** |
| Parents | 12 | 16.42 ** | 16.79 ** | 743.31 ** | 51.23 ** | 40.50 ** | 402.17 * | 0.04 ** | 20.91 ** | 1158.30 ** |
| Hybrids | 21 | 6.06 ** | 28.30 ** | 430.14 ** | 29.32 ** | 28.05 ** | 2388.71 ** | 0.02 * | 7.21 ** | 563.49 ** |
| Males | 10 | 8.74 ** | 37.52 ** | 620.17 ** | 45.62 ** | 35.77 ** | 3014.74 ** | 0.03 ** | 9.08 ** | 821.21 ** |
| Females | 1 | 17.46 ** | 113.70 ** | 1087.52 ** | 89.57 ** | 134.69 ** | 11167.78 ** | 0.02 | 44.00 ** | 871.65 ** |
| Females x Males | 10 | 2.25 | 10.53 ** | 174.36 * | 7.00 ** | 9.66 * | 884.76 ** | 0.01 | 1.67 ** | 274.95 * |
| Parents x Hybrids | 1 | 98.28 ** | 204.57 ** | 1830.33 ** | 125.08 ** | 121.73 ** | 1851.93 ** | 0.14 ** | 39.64 ** | 2552.42 ** |
| Error | 68 | 1.62 | 2.17 | 68.61 | 2.29 | 2.66 | 194.63 | 0.01 | 0.16 | 136.10 |
| $2_{gca}$ |  | 0.09 | 0.41 | 5.96 | 0.51 | 0.43 | 34.91 | 0.00024 | 0.13 | 6.81 |
| $2_{sca}$ |  | 0.21 | 2.79 | 35.25 | 1.57 | 2.33 | 230.04 | 0.00037 | 0.50 | 46.28 |
| $2_{gca/}\ 2_{sca}$ |  | 0.43 | 0.15 | 0.17 | 0.33 | 0.18 | 0.15 | 0.65 | 0.26 | 0.15 |

*,** P < 0.05 and 0.01, respectively

Table 3 : Estimates of general combining ability effects of parents for yield and yield components in pigeonpea.

| Parents | Days to 50 per cent flowering | Days to maturity | Plant height (cm) | Primary branches per plant | Secondary branches per plant | Pods per plant | Seeds per pod | 100-seed weight (g) | Seed yield per plant (g) |
|---|---|---|---|---|---|---|---|---|---|
| Males | | | | | | | | | |
| ICP 2376 | 2.63** | 7.30** | -0.79 | 1.02 | 14.87** | -68.89** | 0.06 | -0.30 | -4.74** |
| ICP 7035 | 3.63** | 14.10** | 2.52 | -0.74 | 0.23 | -74.24** | 0.27** | 3.17 | -16.29** |
| ICP 7349 | -3.88** | -2.90** | -1.64 | -0.19 | -6.02** | -6.74 | -0.24** | -1.43 | -0.52** |
| ICP 7994 | -6.63** | 1.10 | 1.72 | 1.01 | 0.03 | 11.51* | 0.01 | -1.77 | -9.94** |
| ICP 8006 | 4.93** | 16.60** | 18.23** | -1.04 | -3.07** | -98.75** | 0.11** | 2.20 | -17.44** |
| ICP 8136 | 3.70** | 2.80** | 5.08 | 0.96 | 4.41** | -1974 | 0.09* | 0.83 | 9.97** |
| ICP 8850 | -1.88** | -12.15** | -21.59** | -1.39* | -10.12** | -29.99** | 0.01 | 0.42 | -18.27** |
| ICP 8863 | -0.38 | -12.15** | 8.87* | -0.14 | -2.77** | 25.36** | -0.04 | 0.28 | -0.24 |
| ICP 11251 | -1.63** | -3.90** | -4.33 | -1.49* | -11.47** | 30.71** | -0.19** | -0.75 | 37.19** |
| BDN 1 | 0.38 | -11.40** | -11.44** | 0.62 | 4.58** | 84.01** | 0.01 | -0.05 | 7.23** |
| LRG 30 | -0.88 | 0.60 | 3.37 | 1.37* | 9.33** | 146.76** | -0.09* | -2.60 | 13.06** |
| S.E.(g) | 0.52 | 0.60 | 3.38 | 0.62 | 0.67 | 5.70 | 0.04 | 4.76 | 0.16 |
| Females | | | | | | | | | |
| ICP MS 288 | -10.83** | -27.80** | -20.15** | -3.32** | -15.34** | -95.45** | 0.17** | -0.01 | -24.86** |
| ICP MS 3783 | 10.83** | 27.80** | 20.15** | 3.32** | 15.34** | 95.45** | -0.17 | 0.01 | 24.86** |
| S.E. (g) | 0.22 | 0.26 | 1.44 | 0.26 | 0.28 | 2.43 | 0.02 | 2.03 | 0.07 |

*,** $P < 0.05$ and 0.01, respectively

to be a good combiner for seed yield by Omanga, 1984 and Saxena *et al.*, 1985), a tolerant parent, though a good choice for improvement of seed yield and yield components, may lead to delayed maturity and increased plant height of the progenies. LRG 30 showed high *gca* effect for yield and its components, as reported by Cheralu *et al.* (1989). ICP 7035, SM resistant and vegetable type, was best combiner for seeds per pod conforming to the findings of Venkateswarlu and Singh (1982). ICP 8136, another SM resistant male parent was good combiner for seed yield, seeds per pod and number of secondary branches. The tolerant parent, ICP 11251, was good general combiner for seed yield, number of pods per plant, early flowering and maturity. Most of the SM resistant parents were, in general, found to be poor combiners for seed yield and majority of yield components.

Desirable and significant *sca* effects were noticed in five hybrids (ICP MS 288 x ICP 7349, ICP MS 288 x ICP 11251, ICP MS 3783 x BDN 1, ICP MS 3783 x LRG 30 and ICP MS 3783 x ICP 8863) for seed yield. ICP MS 288 x ICP 7349, which had high *sca* effects for seed yield, involved both SM resistant parents with low *gca* effects for seed yield and its component characters. This indicated dominance x dominance type of gene action and may be utilized for the production of resistant hybrids with high heterotic effects for seed yield. This cross also possessed desirable *sca* effects for plant height, secondary branches, and pods per plant. ICP MS 288 x ICP 11251 and ICP MS 3783 x ICP 8863 with high *sca* effects for seed yield involved one good general combiner, indicating an additive x dominance type of gene interaction. ICP MS 3783 x BDN 1 and ICP MS 3783 x LRG 30 with high *sca* effects for seed yield involved both high general combiners, suggesting the role of additive x additive gene effects. Crosses involving parents with high x low and low x low *gca* effects could result in desirable transgressive segregants possessing resistance to sterility mosaic coupled with high yield potential.

## ACKNOWLEDGEMENTS

The senior author is grateful to the Council of Scientific and Industrial Research (CSIR), New Delhi, for the award of Senior Research Fellowship. He is also thankful to ICRISAT Asia Center, Patancheru, India, for providing field facilities for carrying out the research.

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(Received on 16-03-2000 and revised on 1-12-2003)

*The Andhra Agric.* J. **50** (3&4) : 227 - 230, 2003

# Genetic Divergence in Rice

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## ABSTRACT

Forty-four rice (*Oryza sativa.* L) genotypes were evaluated for genetic diversity and were grouped into eleven distinct clusters. The pattern of distribution of genotypes from different regions into various clusters was at random, which indicates that geographic isolation may not be only factor causing genetic diversity. Productive tillers, filled grains per panicle, yield per plant, panicle yield per plant and panicle length contributed maximum extent to the expression of genetic divergence. These characters were found to be potent factors for differentiation among the genotypes of rice.

**Key words :** Genetic Divergence, Rice, Genotypes.

The quantification of degree of divergence in the germplasm collection of any crop species is of immence value in identifying diverse genotypes for recombination breeding programmes. This was also useful for discriminating among populations in habitating from similar ecological or geographical regions. Mahalanobis $D^2$ statistics has proved to be a powerful tool for quantifying genetic divergence in a given population in respect of characters under consideration.

Rice (*Oryza sativa.* L) is the major source of food for nearly half of the world population. Over 95 per cent of the world rice is used for human food and provides more than 50 percent of the caloric intake for one out of every three persons on earth. In India, rice is cultivated in about 42 million hectares, which constitutes about 33 per cent of the total area under food grain with a production of 75 million tones, which accounts to 41.5 per cent of the total food grain production. Rice offers a wealth of material for genetical studies because of its wide ecological distribution and enormous variation encountered for various morphological and physiological characters.

## MATERIAL AND METHODS

Forty-four Rice genotypes of different geographical regions were raised in randomized block design with three replications. Each genotype was planted in 3 rows and each row of 3 meters length with a spacing of 20 x 15 cm (60 hills per plot) at Agricultural College fram, Bapatla. The crop was fertilized at the rate of 80 kg N, 40 kg $P_2O_5$ and 30 kg $K_2O$ per ha. Half of the nitrogen and entire $P_2O_5$ and $K_2O$ were applied as basal dressing. The remaining nitrogen was applied in two equal split doses, one at 30 days after planting and the remaining dose at 60 days after planting. Data was collected on 9 characters *viz.,* plant height (cm), days to 50 percent flowering, number of ear bearing tillers per plant, panicle length (cm), number of spikelets per panicle, number of filled grains per panicle, 100 grain weight (g), grain L/B ratio and grain yield per plant (g). Observations were recorded from ten randomly selected plants of middle rows and the mean values were used for statistical analysis of Mahalanobis $D^2$ statistics (1936).

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Table 1 : Distribution of 44 genotypes of rice in different clusters.

| Cluster | No. of Genotypes | Genotypes | Source |
|---|---|---|---|
| I | 11 | BPT 9926, BPT 6093, BPT 4245, BPT 2685, BPT 4267 BPT 2224, BPT 6038, BPT 4244, BPT 3301, BPT 8233 and BPT 9938. | Rice Research Unit, Bapatla |
| II | 13 | BPT 6868, Orumundakan, BPT 6884, BPT 4358, BPT 1235, BPT 6859, BPT 11690, BPT 3264, BPT 2740, BPT 4365, BPT 4363, BPT 11711 and BPT 2217 | Rice Research Unit, Bapatla |
| III | 5 | Majila, Balam, ARC 10550, BPT 6866 and ARC 6650. | DRR, Hyderabad |
| IV | 2 | Sinnasivappu and PTB 21, | Srilanka & Pattambi |
| V | 1 | T(N) 1 | DRR, Hyderabad |
| VI | 3 | ARC 10654, Tetep and Velluthacheera. | CRRI, Cuttack |
| VII | 4 | Eswarakorra, Siam - 29, Rathunheenati and PTB - 12 | ARS, Nellore |
| VIII | 1 | BPT 3291 | Rice Research Unit, Bapatla |
| IX | 1 | BPT 1768 | Rice Research Unit, Bapatla |
| X | 2 | BPT 856 and BPT 5204 | Rice Research Unit, Bapatla |
| XI | 1 | ADR 52 | Aduturia, T.N. |

## RESULTS AND DISCUSSION

The analysis of variance relealed that highly significant differences were observed among the genotypes for all the 9 characters studied indicating the presence of genetic variability for all the characters. Based on Mahalanobis $D^2$ values, the forty-four genotypes were grouped into eleven clusters and the genotype composition of each cluster was given in Table 1. Among them, cluster II was the largest with 13 genotypes followed by cluster I with 11 genotypes, cluster III with 5 genotypes, cluster VII with 4 genotypes, cluster VI with 3 genotypes, cluster IV and X with 2 genotypes and other clusters viz., V, VIII, IX and XI with one genotype each.

Genotypes originating from the same place were scattered in different clusters as observed from Table 1. The genotypes of Rice Research Unit, Bapatla (A.P.) had been distributed in different clusters viz., I, II, III, VIII, IX and X. This clearly showed that geographical diversity and genetic diversity were not related. This suggests that the forces other than geographical separation such as: exchange of breeding material, genetic drift, natural and artificial selection, environmental variation were also responsible for this diversity. Similar conclusions have been arrived by Suyambulinagam and Jebrani (1998), Singh and Chaudhary (1979), Singh (1983) and Ratho (1984).

The highest inter cluster distance was observed between cluster VI and XI (530.281), while the minimum inter cluster distance was observed between 8 and 9 (44.022) followed by cluster X and IX (455.645) and followed by cluster III and IV (433.814) (Table 2). Cluster VI was highly divergent from cluster IX, X, VIII and VII. Similarly cluster XI is also highly divergent from clusters X, XI, VII and I. The genotypes in these clusters can be utilized as potential parents and crossing between these genotypes results in heterotic expression for yield components. The per cent contribution towards genetic divergence by all the nine contributing characters were presented in Table 3. The character, productive tillers contributed maximum to the

Table 2 : Intra and Inter cluster average of $D^2$ and D (Parenthesis) Values of eleven Clusters Estimated from 44 Genotypes of Rice.

| Cluster | I | II | III | IV | V | VI | VII | VIII | IX | X | XI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I | 160.897 | 106.754 | 224.996 | 219.302 | 185.857 | 318.374 | 172.095 | 66.717 | 103.362 | 69.612 | 315.756 |
|  | (12.684) | (10.332) | (14.999) | (14.808) | (13.632) | (17.843) | (13.118) | (8.168) | (10.166) | (8.343) | (17.769) |
| II |  | 217.185 | 108.435 | 126.984 | 72.252 | 138.091 | 221.542 | 76.776 | 214.109 | 179.493 | 106.664 |
|  |  | (14.737) | (10.413) | (11.268) | (8.500) | (11.751) | (14.884) | (8.762) | (14.632) | (13.397) | (10.327) |
| III |  |  | 199.470 | 81.984 | 159.619 | 96.233 | 213.160 | 278.238 | 433.814 | 208.590 | 95.411 |
|  |  |  | (14.123) | (9.054) | (12.634) | (9.809) | (14.600) | (16.680) | (20.828) | (14.442) | (9.767) |
| IV |  |  |  | 9.366 | 217.539 | 133.211 | 95.992 | 278.220 | 393.768 | 372.323 | 115.472 |
|  |  |  |  | (3.060) | (14.749) | (11.541) | (9.797) | (16.679) | (19.843) | (19.295) | (10.745) |
| V |  |  |  |  | --- | 206.916 | 361.711 | 124.177 | 260.735 | 300.888 | 65.739 |
|  |  |  |  |  | --- | (14.384) | (19.018) | (11.143) | (16.147) | (17.346) | (8.107) |
| VI |  |  |  |  |  | 106.189 | 256.277 | 303.947 | 530.281 | 405.942 | 132.760 |
|  |  |  |  |  |  | (10.304) | (16.008) | (17.434) | (23.030) | (20.148) | (11.522) |
| VII |  |  |  |  |  |  | 155.359 | 319.623 | 335.925 | 300.629 | 320.154 |
|  |  |  |  |  |  |  | (12.464) | (17.878) | (18.328) | (17.338) | (17.892) |
| VIII |  |  |  |  |  |  |  | --- | 44.022 | 65.459 | 250.774 |
|  |  |  |  |  |  |  |  | --- | (6.634) | (8.090) | (15.835) |
| IX |  |  |  |  |  |  |  |  | --- | 134.552 | 405.030 |
|  |  |  |  |  |  |  |  |  | --- | (11.599) | (20.125) |
| X |  |  |  |  |  |  |  |  |  | 29.158 | 455.645 |
|  |  |  |  |  |  |  |  |  |  | (5.399) | (21.345) |
| XI |  |  |  |  |  |  |  |  |  |  | --- |

Table 3 : Contribution of different characters towards genetic divergence in 44 genotypes of rice.

| S.No. | Character | % of contribution to wards divergence |
|---|---|---|
| 1. | Productive tillers per plant | 14.61 |
| 2. | Filled grains per panicle | 12.67 |
| 3. | Yield per panicle | 11.62 |
| 4. | Panicle length | 11.09 |
| 5. | L/B ratio | 9.61 |
| 6. | 100-grain wt | 8.60 |
| 7. | Plant height | 7.29 |
| 8. | Total spikelets per panicle | 6.76 |
| 9. | Days to 50% flowering | 6.07 |

Table 4 : Mean value of clusters estimated from 44 genotypes of rice for 9 quantitative traits.

| Traits | I | II | III | IV | V | VI | VII | VIII | IX | X | XI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant height (cm) | 85.2 | 97.3 | 127.7 | 145.8 | 67.2 | 148.4 | 142.7 | 69.1 | 76.7 | 84.4 | 109.1 |
| Days to 50 % Flowering | 119.4 | 104.9 | 99.4 | 108.1 | 102.0 | 99.0 | 121.3 | 111.0 | 120.6 | 101.1 | 97.0 |
| Productive tillers per plant | 8.2 | 8.9 | 8.0 | 10.9 | 13.4 | 11.7 | 9.6 | 8.6 | 7.8 | 9.4 | 9.5 |
| Panicle length (cm) | 21.3 | 21.5 | 25.4 | 21.2 | 21.4 | 25.8 | 22.6 | 18.4 | 21.1 | 19.9 | 20.8 |
| Total spikelets per panicle | 148.9 | 137.7 | 119.1 | 95.8 | 108.5 | 115.7 | 109.4 | 160.6 | 205.7 | 181.5 | 88.4 |
| Filled grains per panicle | 117.4 | 108.4 | 94.3 | 84.0 | 86.9 | 96.6 | 92.7 | 124.8 | 164.8 | 132.8 | 76.5 |
| 100 - grain weight (g) | 1.89 | 1.93 | 2.64 | 2.43 | 1.68 | 2.06 | 2.65 | 1.45 | 1.61 | 1.47 | 1.90 |
| L/B ratio | 3.02 | 2.98 | 2.85 | 2.78 | 2.57 | 3.10 | 2.82 | 3.15 | 2.25 | 3.40 | 2.38 |
| Grain yield per plant (g) | 18.2 | 18.5 | 19.5 | 20.0 | 18.7 | 24.3 | 22.5 | 15.4 | 20.6 | 19.0 | 13.9 |

genetic divergence (14.61) followed by filled grains per panicle (12.67), yield per plant (11.62), panicle length (11.09), L/B ratio (9.61), 100 grain weight (8.60), plant height (7.29), total spikelets per panicle (6.76) and days to 50% flowering (6.07). The cluster means of various characters are presented in (Table 4). The cluster IX recorded the highest mean for total spikelets per panicle and filled grains per panicle and the lowest L/B ratio. Cluster VI recorded the highest mean for panicle length, plant height and grain yield per plant. The highest mean for productive tillers, 100 grain weight and L/B ratio were observed in clusters viz., V, VII and X, respectively. Thus by involving the genotypes of these clusters, as parents colud be useful to generate wide range of variabiity which could be selected for these characters derive new genetic stocks and also for higher yields with of quality grain can be developed.

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(Received on 11-02-2003 and revised on 11-09-2003)

*The Andhra Agric.* J. **50** (3&4) : 231 - 234, 2003

# Correlation and Path Analysis of Certain Quantitative and Physiological Characters in Rice (*Oryza sativa* L.)

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## ABSTRACT

Genotypic and Phenotypic correlations and path coefficient analysis were worked out for thirteen quantitative and physiological characters influencing the yield in rice. Number of productive tillers per hill, total chlorophyll, amylose content, leaf nitrogen per cent and number of grains per panicle exhibited significant positive correlation with yield. Path coefficient analysis revealed that number of productive tillers per hill and number of grains per panicle showed higher positive direct effect on yield. Hence for improving grain yield in rice, selection pressure must be applied on number of productive tillers per hill and number of grains per panicle.

**Key words :** Correlation, Path analysis, Physiological Characters.

Rice is the third largest food crop in the world, which feeds 1/3 rd of worlds population either as direct staple food or a part of diet. The need for increasing rice yield to feed the galloping population, which is being doubled at decreasing intervals, need not be over stated. Grain yield is a complex trait and is a result of interaction of many of its components. While selecting for yield, the nature of correlation between yield and component traits and their direct and indirect effects on yield are of great significance in any breeding programme towards crop improvement. The present investigation was undertaken with the objectives of understanding the nature of association among the yield components of six parents and 15 $F_1$ crosses.

## MATERIAL AND METHODS

The 15 $F_1$ cross combinations involving 6 parents viz., ARC 5780, BPT 5204, BPT 1768, MTU 2067, NLR 33641 and BPT 4358 were raised in a randomised block design with 3 replications along with the parents, during the *rabi* 1999 - 2000. Observations were recorded on five randomly chosen plants from the central row under each replication in hybrids and parents. The correlation coefficients and path coefficients were worked out following the method suggested by Johnson *et al.* (1955) and Dewey and Lu (1959), respectively.

## RESULTS AND DISCUSSION

The genotypic correlation coefficients were higher than the phenotypic correlation coefficients in general (Table 1); The low phenotypic correlations might be due to the masking of modifying effect of environment in genetic association between characters (Johnson *et al.*, 1955). Each of the 6 characters viz., number of productive tillers per hill, total chlorophyll, amylose content, harvest index, number of grains per panicle and leaf nitrogen per cent were positively correlated with yield. These findings are in agreement with those of the earlier workers who found a positive association between number of productive tillers per hill (Ganesan and Rangaswamy, 1998), total chlorophyll (Kumar and Singh, 1996) amylose content (Chauhan and Nanda, 1983), harvest index (Prashant *et al.*, 1999), number of grains per panicle (Nath and

Table 1 : Genotypic and phenotypic correlations between different characters in rice.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.000 | 0.569**<br>(0.892)** | -0.212<br>(-0.230) | 0.645**<br>(0.748)** | 0.645**<br>(0.797)** | -0.395**<br>-(0.423)** | 0.606**<br>(0.656)** | 0.063<br>(0.113) | 0.736**<br>(0.840)** | 0.232<br>(0.241) | 0.089<br>(0.123) | -0.212<br>(-0.230) | 0.849**<br>(0.896)** |
| 2 | | 1.000 | -0.237<br>(-0.361)** | 0.361**<br>(0.713)** | 0.458**<br>(0.873)** | -0.369**<br>-(0.692)** | 0.572**<br>(0.997)** | -0.129<br>(-0.080) | 0.309*<br>(0.684)** | -0.144<br>(-0.220) | 0.023<br>(0.101) | -0.237<br>(-0.362)** | 0.532**<br>(0.913)** |
| 3 | | | 1.000 | 0.020<br>(-0.016) | -0.127<br>(-0.189) | 0.133<br>(0.165) | -0.353**<br>-(0.366)** | -0.225<br>-(0.299)* | -0.215<br>(-0.242) | 0.145<br>(0.152) | -0.024<br>(-0.049) | 1.000**<br>(1.000)** | -0.114<br>(-0.130) |
| 4 | | | | 1.000 | 0.447**<br>(0.796)** | -0.323**<br>-(0.618)** | 0.534**<br>(0.684)** | 0.302*<br>(-0.195) | 0.532**<br>(0.849)** | 0.137<br>(-0.049) | 0.093<br>(0.303)* | 0.020<br>(-0.131) | 0.499**<br>(0.610)** |
| 5 | | | | | 1.000 | -0.150<br>(0.095) | 0.624**<br>(0.769)** | 0.005<br>(0.070) | 0.452**<br>(0.646)** | 0.080<br>(0.150) | 0.280*<br>(0.389)** | -0.128<br>(-0.189) | 0.630**<br>(0.796)** |
| 6 | | | | | | 1.000 | -0.399**<br>-(0.465)** | 0.296*<br>(0.306)* | -0.454**<br>(-0.614)** | 0.525**<br>(0.618)** | 0.056<br>(-0.068) | 0.134<br>(0.165) | -0.515**<br>(0.618)** |
| 7 | | | | | | | 1.000 | 0.099<br>(0.147) | 0.541**<br>(0.590)** | -0.333**<br>(-0.368)** | 0.155<br>(0.193) | -0.354**<br>(-0.367)** | 0.643**<br>(0.684)** |
| 8 | | | | | | | | 1.000 | 0.137<br>(0.180) | 0.167<br>(0.234) | 0.021<br>(-0.046) | -0.225<br>(-0.229) | -0.088<br>(-0.195) |
| 9 | | | | | | | | | 1.000 | (-0.128)<br>(-0.135) | 0.085<br>(0.134) | -0.216<br>(-0.242) | 0.761**<br>(0.849)** |
| 10 | | | | | | | | | | 1.000 | 0.054<br>(0.065) | 0.145<br>(0.152) | -0.048<br>(-0.049) |
| 11 | | | | | | | | | | | 1.000 | -0.025<br>(-0.049) | 0.232<br>(0.303) |
| 12 | | | | | | | | | | | | 1.000 | -0.114<br>(-0.131) |
| 13 | | | | | | | | | | | | | 1.000 |

Figures in parenthesis are genotypic correlation coefficients.

**, * - Significant at 1% and 5% levels respectively.

1. Number of productive tillers per hill 2 . Total chlorophyll (%) 3. Test weight (g) 4. Amylose content (%) 5. Harvest Index (HI) 6. Protein content (%) 7. Number of grains per panicle 8. Leaf area index (LAI) 9. Leaf nitrogen (%) 10. Volume expansion ratio 11. L/B ratio 12. Kernel weight (g) 13. Grain yield per plot (kg)

Table 2 : Estimation of direct and indirect effects between yield and yield components.

| | Number of productive tillers per hill | Total chlorophyll (%) | Test weight (g) | Amylose content (%) | Harvest index (HI) | Protein content (%) | Number of grains per panicle | Leaf area index (LAI) | Leaf nitrogen (%) | Volume expansion ratio | L/B ratio | Kernel weight (g) | r,y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of productive tillers per hill | 0.624<br>(0.760) | 0.021<br>(-0.111) | -0.055<br>(-0.542) | -0.136<br>(0.031) | 0.026<br>(-0.074) | 0.057<br>(-0.043) | 0.103<br>(0.141) | -0.002<br>(-0.043) | 0.185<br>(0.249) | -0.006<br>(-0.029) | 0.013<br>(0.020) | 0.019<br>(0.537) | 0.849**<br>(0.896)** |
| Total chlorophyll (%) | 0.355<br>(0.678) | 0.036<br>(-0.124) | -0.062<br>(-0.853) | -0.076<br>(0.029) | 0.018<br>(-0.081) | 0.054<br>(-0.071) | 0.097<br>(0.215) | 0.004<br>(0.030) | 0.078<br>(0.203) | 0.004<br>(0.027) | 0.003<br>(0.017) | 0.021<br>(0.843) | 0.532**<br>(0.913)** |
| Test weight (g) | -0.132<br>(-0.174) | -0.009<br>(0.045) | 0.260<br>(2.361) | -0.004<br>(-0.001) | -0.005<br>(0.017) | -0.019<br>(-0.017) | -0.060<br>(0.079) | 0.006<br>(-0.113) | -0.054<br>(-0.072) | -0.004<br>(-0.018) | -0.004<br>(-0.008) | -0.090<br>(-2.331) | -0.114<br>(-0.130) |
| Amylose content % | 0.402<br>(0.568) | 0.013<br>(-0.089) | 0.005<br>(-0.038) | -0.211<br>(0.041) | 0.018<br>(-0.064) | 0.047<br>(-0.035) | 0.091<br>(0.144) | -0.008<br>(-0.203) | 0.134<br>(0.218) | -0.003<br>(-0.130) | 0.014<br>(0.041) | -0.002<br>(0.039) | 0.499**<br>(0.610)** |
| Harvest index (HI) | 0.408<br>(0.606) | 0.017<br>(-0.108) | -0.033<br>(-0.445) | -0.094<br>(0.028) | 0.039<br>(-0.093) | 0.022<br>(-0.010) | 0.106<br>(0.166) | 0.000<br>(-0.027) | 0.114<br>(0.192) | -0.002<br>(-0.018) | 0.042<br>(0.064) | 0.011<br>(0.441) | 0.630<br>(0.796)** |
| Protein content % | -0.246<br>(-0.322) | -0.013<br>(0.086) | 0.035<br>(0.389) | 0.068<br>(-0.014) | -0.006<br>(0.009) | -0.146<br>(0.103) | -0.068<br>(-0.100) | -0.008<br>(-0.116) | -0.114<br>(-0.182) | -0.013<br>(-0.075) | 0.008<br>(-0.011) | -0.012<br>(-0.385) | -0.515**<br>(-0.618)** |
| Number of grains per panicle | 0.378<br>(0.499) | 0.021<br>(-0.124) | -0.092<br>(-0.864) | -0.113<br>(0.027) | 0.024<br>(-0.071) | 0.058<br>(-0.048) | 0.170<br>(0.215) | -0.003<br>(-0.056) | 0.136<br>(0.175) | 0.008<br>(0.044) | 0.023<br>(0.032) | 0.032<br>(0.855) | 0.643**<br>(0.684)** |
| Leaf area index (LAI) | 0.039<br>(0.086) | -0.005<br>(0.010) | -0.058<br>(-0.705) | -0.064<br>(0.022) | 0.000<br>(-0.007) | -0.043<br>(0.031) | 0.017<br>(0.032) | -0.028<br>(-0.379) | 0.034<br>(0.053) | -0.004<br>(-0.028) | 0.003<br>(-0.008) | 0.020<br>(0.697) | -0.088<br>(-0.195) |
| Leaf nitrogen % | 0.459<br>(0.639) | 0.001<br>(-0.085) | -0.056<br>(-0.571) | -0.112<br>(0.030) | 0.018<br>(-0.060) | 0.066<br>(-0.063) | 0.092<br>(0.127) | -0.004<br>(-0.068) | 0.251<br>(0.297) | 0.003<br>(0.016) | 0.013<br>(0.022) | 0.019<br>(0.565) | 0.761**<br>(0.849)** |
| Volume expansion ratio | 0.145<br>(0.183) | -0.005<br>(0.027) | 0.038<br>(0.358) | -0.029<br>(0.004) | 0.003<br>(-0.014) | -0.076<br>(0.063) | -0.057<br>(-0.079) | -0.005<br>(-0.089) | -0.032<br>(-0.040) | -0.025<br>(-0.121) | 0.008<br>(0.011) | -0.013<br>(-0.353) | -0.048<br>(-0.049) |
| L/B ratio | 0.056<br>(0.094) | 0.001<br>(-0.013) | -0.006<br>(-0.115) | -0.020<br>(0.010) | 0.011<br>(-0.036) | -0.008<br>(-0.007) | 0.026<br>(0.042) | -0.001<br>(0.017) | 0.021<br>(0.040) | -0.001<br>(-0.008) | 0.151<br>(0.164) | 0.002<br>(0.115) | 0.232<br>(0.303) |
| Kernel weight (g) | -0.132<br>-(0.175) | -0.009<br>(0.045) | 0.260<br>(2.361) | -0.004<br>(-0.001) | -0.005<br>(0.018) | -0.019<br>(0.017) | -0.060<br>(-0.079) | 0.006<br>(0.113) | -0.054<br>(-0.072) | -0.004<br>(-0.018) | -0.004<br>(-0.008) | -0.090<br>(-2.331) | -0.114<br>(-0.131) |

Figures in parenthesis are genotypic correlation coefficients.

Underlined values are direct effects and all other values are indirect effects.

**, * - Significant at 1% and 5% levels respectively.

Talukdar, 1997 and Reddy *et al.*, 1997), leaf nitrogen % (Kumar and Singh, 1996) and yield.

The perusal of interrelationship between yield characters indicated an interesting observation was made i.e., number of productive tillers per hill, total chlorophyll, amylose content, harvest index, number of grains per panicle and leaf nitrogen per cent were mutually correlated with each other. Productive tillers per hill was by itself positively and significantly correlated with total chlorophyll, amylose content, harvest index, number of grains per panicle and leaf nitrogen per cent. Total chlorophyll showed a positive and significant association with amylose content, harvest index, number of grains per panicle and leaf nitrogen per cent. Amylose content was positively and significantly correlated with harvest index, number of grains per panicle, and leaf nitrogen per cent. Harvest index was positively and significantly correlated with number of grains per panicle and leaf nitrogen per cent. Number of grains per panicle was positively and significantly correlated with leaf nitrogen per cent. Therefore, selection for any one of the characters or one or two characters together would offer scope for simultaneous improvement in all these 6 characters in addition to improving the yield. High HI indicates the efficiency of the cultivars in making use of the nutrients and also the physiological capacity to convert the total photosynthate into economic products. The high correlation of HI with the major important components of yield like productive tillers, amylose content, total chlorophyll, number of grains per panicle, and leaf nitrogen per cent may be taken advantage for yield improvement through selection for high HI.

Path analysis (Table 2) revealed that number of productive tillers per hill was the most important character because of its higher positive direct effect. The maximum positive direct effect on grain yield per plant exerted by number of productive tillers per hill was also reported by Murthy *et al.* (1997). The direct effect of number of grains per panicle and leaf nitrogen per cent was considerably low. Similar low direct effect had been reported by Verma *et al.* (1997). The remaining traits had negligible direct effect. There was substantial indirect effect through number of productive tillers per hill, leaf nitrogen per cent and number of grains per panicle. Low residual effect (0.1373) indicated that the characters included in this study were adequate and appropriate.

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(Received on 17-12-2000 and revised on 5-11-2001)

*The Andhra Agric.* J. **50** (3&4) : 235 - 237, 2003

# Induced Variability and Character Association of Nitrogen fixation Traits in *Phaseolus vulgaris* L.

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## ABSTRACT

Variability and character associations were studied for eleven characters in twelve induced mutants and its parent (PDR-14) in rajmash. The study indicated that selection programme with due emphasis on leaf area, total nitrogen per plant, number of pods per plant and keeping the plant dry weight to an optimum level is bound to prove useful in developing superior genotypes with high nitrogen fixation and yield in French bean.

**Key words :** Nitrogen fixation, EMS, Gamma rays, heritability, genetic advance.

Rahjmash (*Phaseolus vulgaris* L.) a newly introduced *rabi* pulse, is becoming popular in the Northern plains of India. Its area is gradually increasing but in contrast, its yield is very low in terms of productivity. The present study is aimed at improvement of nitrogen fixing ability and yield components to boost overall grain yield.

## MATERIAL AND METHODS

A well adapted variety PDR-14 was subjected to mutagenic treatment with Ethyl Methane Sulphonate, gamma rays and their interaction. In $F_3$ generation twelve mutants were identified and sown in randomized complete block design with three replications along with control, during *rabi* at Agricultural Research Farm, Banaras Hindu University, Varanasi. At pre flowering stage 10 plants from each mutant line per replication were selected. Five of them were utilized for recording leaf area, nitrate reductase activity (NRA) [as per Srivastava (1974)] and under ground traits, number of nodules per plant, nodule dry weight, plant dry weight and total nitrogen per plant [Novozamsky *et al.,* 1974]. On maturity, the remaining samples were utilized for recording number of pods per plant, number of seeds per plant, 100 seed weight, grain yield and seed protein per cent.

The mean data were subjected to compute genotypic coefficient of variability (GCV). Phenotypic coefficient of variation (PCV), heritability (BS) and genetic advance. Path analysis was carried out to partition the genotypic correlation into direct and indirect effects (Dewey and Lu, 1959).

## RESULTS AND DISCUSSION

Significant differences were observed for all the characters studied. The mean, GCV, PCV, heritability and genetic advance are given in Table-1. Both the GCV and PCV was higher for nodule dry weight, nitrate reductase activity, nodule number, plant dry weight, leaf area, yield and seed protein, while remaining traits showed low values for GCV and PCV. The values of PCV were higher than the corresponding GCV values.

Heritability estimates for leaf area, nodule number, nodule dry weight, Plant dry weight, total

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Table 1 : Estimates of GCV, PCV, Heritability and Genetic advance (GA) in different traits of induced mutants of *Phaseolus vulgaris* L. cv. PDR - 14.

| S.No. | Character | Mean | Range | Coeff. of Variation | Coeff. of Variation (Geno) | Heritability (Pheno) | GA (K = 2.06) (BS)* |
|---|---|---|---|---|---|---|---|
| 1. | Leaf area | 411.84 | 354.66 - 475.26 | 11.46 | 11.85 | 0.935 | 89.46 |
| 2. | Nodule No./plant | 43.76 | 25.00 - 52.00 | 17.47 | 18.05 | 0.938 | 18.47 |
| 3. | Nodule Dry wt. | 87.91 | 52.25 - 111.38 | 22.94 | 23.46 | 0.956 | 47.04 |
| 4. | Plant Dry wt. | 10.44 | 9.57 - 11.72 | 16.84 | 17.34 | 0.943 | 2.57 |
| 5. | Total N/plant | 365.88 | 289.11 - 468.16 | 16.42 | 16.92 | 0.941 | 36.39 |
| 6. | No. of pods/plant | 9.75 | 8.06-11.86 | 7.91 | 8.81 | 0.807 | 1.43 |
| 7. | No. of seeds/pod | 4.45 | 3.93 - 5.00 | 7.95 | 8.98 | 0.784 | 0.65 |
| 8. | 100 - seed weight | 34.86 | 31.92 - 38.05 | 6.16 | 6.56 | 0.882 | 4.16 |
| 9. | Yield / plant | 18.67 | 14.54 - 20.84 | 12.70 | 13.57 | 0.876 | 4.57 |
| 10. | NRA | 8.02 | 6.16 - 11.75 | 17.98 | 18.14 | 0.982 | 2.95 |
| 11. | Seed protein % | 21.60 | 19.52 - 23.31 | 11.26 | 13.41 | 0.814 | 2.89 |

* Broad sense

nitrogen per plant and NRA were high, indicating that these traits were less influenced by environment. Number of pods, number of seeds, 100-seed weight, yield per plant and per cent seed protein recorded moderate heritability.

As heritability in broad sense includes both additive and epistatic gene effects it will be reliable only if accompanied by high genetic advance. In the present study, high heritability coupled with high genetic advance was observed for leaf area, nodule dry weight and total nitrogen per plant showing that these traits were controlled by additive gene effects. Nodule number per plant had high heritability and moderate genetic advance indicating pre dominant influence of non-additive gene effects for their expression.

The genotypic correlation coefficient and path analysis of genotypic correlation are presented in Table -2. Grain yield was significantly and positively correlated with leaf area, nodule number per plant, nodule dry weight, plant dry weight, total nitrogen per plant, number of pods per plant and 100-seed weight, Significant negative association with NRA and non significant but negative association with seed protein. The maximum direct positive contribution towards yield was by number of pods per plant followed by leaf area, nodule number and 100 seed weight. Maximum negative direct effect on yield was recorded for plant dry weight (Chandrababu *et al.*, 1992). Although leaf area had moderate direct effect, its positive association with yield was predominantly due to its indirect contribution through nodule number, nodule dry weight, total nitrogen, number of pods and 100 seed weight. Similarly Park and Buttery (1989), Burias and Planchanon (1990), and Pentalon *et al.* (1996) reported high positive correlation between seed yield and nodule number, nodule dry weight and total nitrogen per plant.

In the present study, plant dry weight though positively associated with yield its direct contribution to yield is negative, thus limiting its direct selection. Total nitrogen per plant could be taken as criteria for improving both nitrogen fixation and yield. Based on the above

Table 2 : Path Coefficients - Direct effects (underline) and indirect effects in M3 generation of *Phaseolus vulgaris* L. cv. PDR- 14

| | LA | NN | NDW | PDW | TNP | NPD | NSP | 100 SW | NRA | SP | 'r' |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Leaf area | 0.480 | 0.386 | 0.403 | 0.446 | 0.274 | 0.297 | -0.108 | 0.322 | -0.369 | 0.150 | 0.682* |
| Nodule No. per plant | 0.261 | 0.425 | 0.306 | 0.273 | 0.170 | 0.208 | 0.024 | 0.206 | -0.264 | 0.104 | 0.831** |
| Nodule dry weight | 0.027 | 0.030 | 0.032 | 0.027 | 0.019 | 0.021 | 0.081 | 0.021 | -0.025 | 0.008 | 0.824** |
| Plant dry weight | 0.792 | -0.078 | -0.035 | -0.854 | 0.561 | -0.361 | -0.130 | 0.616 | 0.277 | -0.365 | 0.700** |
| Total N per plant | 0.083 | 0.076 | 0.086 | 0.096 | 0.146 | 0.022 | 0.028 | 0.220 | 0.101 | 0.058 | 0.689** |
| No. of pods per plant | 0.212 | 0.220 | 0.223 | 0.145 | 0.051 | 0.743 | -0.159 | 0.098 | 0.233 | -0.019 | 0.686** |
| No. of seeds per pod | 0.264 | 0.026 | 0.007 | 0.054 | 0.067 | -0.163 | -0.153 | 0.004 | 0.005 | 0.104 | 0.091 |
| 100 seed weight | -0.079 | 0.249 | 0.268 | 0.284 | 0.325 | 0.112 | 0.093 | 0.394 | 0.316 | -0.009 | 0.869** |
| NRA | 0.230 | 0.243 | 0.239 | 0.237 | 0.206 | 0.203 | -0.005 | 0.240 | -0.299 | 0.011 | -0.724** |
| Seed protein | -0.005 | -0.006 | -0.005 | -0.007 | -0.007 | 0.001 | -0.005 | 0.000 | 0.001 | -0.017 | 0.025 |

-- * Significant at 0.05 probability level 'r' - Genotypic Correlation coefficient
** Significant at 0.01 probability level

observations it is suggested that a selection programme with due emphasis on leaf area, total nitrogen per plant, number of pods per plant and keeping the plant dry weight to an optimum level is desired for developing superior genotypes with high nitrogen fixation and yield in French bean.

## ACKNOWLEDGEMENTS

The authors would like to thank University Grants Commission for providing financial assistance.

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(Received on 12-10-2001 and revised on 22-02-2003)

*The Andhra Agric.* J. **50** (3&4) : 238 - 241, 2003

# Integrated use of Fertilizers and Poultry Manure on Nutrient Uptake and Yield of Rice

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## ABSTRACT

A pot culture experiment was conducted to study the integrated use of poultry manure and fertilizer on nutrient uptake and yield of rice grown in a sandy loam soil during *Kharif* 2000. Addition of poultry manure from 0 to 6 t ha$^{-1}$ with 0, 25, 50 and 100 per cent recommended dose of fertilizer increased the grain yield of rice. At added levels of poultry manure the per cent increase in the grain yield was 18.6, 41.2 and 67.0 while with fertilizer 27.2, 47.3 and 78.4 over control, respectively. Nutrient uptake increased and per cent increase was more in phosphorus followed by nitrogen and potassium. Higher uptake of micronutrient cations i.e. Fe, Mn, Cu, and Zn was also observed with the addition of poultry manure.

**Key words :** Integrated use, Poultry Manure, Nutrient uptake.

Poultry manure contains appreciable amounts of essential plant nutrients (N, P, K, S, Ca, Mg, B, Cu, Mn, Fe, Mo and Zn) which are necessary to increase yield, quality of crops and is significant in the maintenance of organic matter content of soil. Nutrient management in coastal sandy soils with some intensive cropping sequences to sustain the crop and soil productivity assumes greater importance as these soils are nutritionally poor. Increasing fertilizer prices and high requirement of nutrients deter the farmers from using the recommended doses of inorganic fertilizers. Hence it becomes imperative to judiciously utilise and integrate the locally available alternative sources of plant nutrient with inorganics to improve productivity. Therefore an experiment was conducted to study the effect of integrated use of fertilizers and poultry manure on nutrient availability and yield of rice grown in a sandy loam soil. The soil used was sandy loam in texture with pH 7.4, EC$_e$ 0.30 dS m$^{-1}$, OC 0.21%, CEC 18.3 C mole (p+) kg$^{-1}$ and contains 250.8, 38.5, 338.8 kg ha$^{-1}$ of NPK and 7.30, 5.80, 0.40 and 0.38 ppm of Fe, Mn, Cu and Zn, respectively.

## MATERIAL AND METHODS

Surface soil collected, processed was taken 10 kg each into an earthen pot and mixed thoroughly with 0, 2, 4 and 6 t ha$^{-1}$ poultry manure and 0, 25, 50 and 100 per cent recommended dose of fertilizer. The entire phosphorus, potassium and half the recommended doses of nitrogen was applied as basal dose and the other half dose of nitrogen was applied as top dressing. Thirty days old seedlings of paddy var. MTU 2067 was transplanted in three replications of two sets, one set of which was removed at maximum tillering stage and the other continued up to harvest. Plant and soil samples collected at both the stages were analysed by adopting standard procedures.

## RESULTS AND DISCUSSION

Application of poultry manure from 0 to 6 t ha$^{-1}$ in combination with 0, 25, 50 and 100 per cent recommended dose of fertilizer increased the grain yield of rice (Table 1). The response of grain yield to poultry manure application was 18.6, 41.2 and 67.0 percent while with fertilizer

Table 2 : Effect of poultry manure applied in combination with inorganic fertilizers on uptake of nitrogen, phosphorus and potassium (mg pot$^{-1}$)

**Maximum tillering stage**

| Treatment | N | | | | | P | | | | | K | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean |
| $P_0$ | 338.8 | 407.3 | 431.3 | 442.1 | 404.9 | 4.84 | 9.60 | 12.45 | 14.46 | 10.33 | 101.7 | 166.6 | 215.2 | 250.2 | 183.4 |
| $P_1$ | 402.6 | 425.6 | 448.1 | 460.6 | 434.2 | 10.57 | 13.56 | 15.45 | 18.53 | 14.45 | 173.2 | 200.8 | 221.5 | 252.4 | 212.0 |
| $P_2$ | 445.5 | 485.4 | 537.7 | 538.5 | 501.8 | 14.46 | 16.51 | 33.30 | 62.81 | 31.77 | 210.7 | 238.4 | 216.1 | 264.5 | 232.4 |
| $P_3$ | 487.1 | 541.1 | 573.7 | 607.7 | 552.4 | 16.34 | 24.70 | 44.12 | 90.18 | 43.83 | 243.2 | 262.4 | 288.2 | 350.3 | 286.1 |
| Mean | 418.5 | 464.8 | 497.7 | 512.2 | | 11.54 | 16.09 | 26.25 | 46.49 | | 182.2 | 217.1 | 235.2 | 279.3 | |
| | | F | P | F x P | | | F | P | F x P | | | F | P | F x P | |
| SEM ± | | 6.97 | 6.97 | 13.94 | | | 0.91 | 0.91 | 1.82 | | | 5.05 | 5.05 | 10.1 | |
| CD(P=0.05) | | 19.84 | 19.84 | NS | | | 2.59 | 2.59 | 5.18 | | | 14.38 | 14.38 | 28.76 | |

**Harvest**

| Treatment | N | | | | | P | | | | | K | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean |
| $P_0$ | 283.3 | 339.2 | 615.0 | 761.1 | 499.7 | 6.62 | 15.32 | 24.37 | 31.89 | 19.55 | 185.9 | 304.0 | 469.1 | 567.2 | 381.7 |
| $P_1$ | 316.6 | 423.4 | 772.4 | 1037.4 | 637.4 | 14.09 | 20.73 | 28.01 | 46.13 | 27.24 | 218.2 | 377.9 | 514.4 | 633.5 | 436.0 |
| $P_2$ | 435.6 | 604.1 | 895.9 | 1161.1 | 774.2 | 23.98 | 28.63 | 46.44 | 58.44 | 39.37 | 283.7 | 456.0 | 567.5 | 683.0 | 487.5 |
| $P_3$ | 458.0 | 745.9 | 987.5 | 1230.7 | 855.5 | 28.63 | 35.00 | 74.43 | 92.29 | 57.59 | 317.3 | 499.8 | 595.5 | 751.3 | 541.0 |
| Mean | 373.4 | 528.2 | 817.7 | 1047.6 | | 18.33 | 24.92 | 43.31 | 57.17 | | 251.2 | 409.4 | 436.6 | 658.7 | |
| | | F | P | F x P | | | F | P | F x P | | | F | P | F x P | |
| SEM ± | | 13.08 | 13.08 | 26.16 | | | 1.26 | 1.26 | 2.52 | | | 7.92 | 7.92 | 15.84 | |
| CD(P=0.05) | | 37.24 | 37.24 | 74.49 | | | 3.58 | 3.58 | 7.17 | | | 22.55 | 22.55 | NS | |

Table 3 : Effect of poultry manure applied in combination with inorganic fertilizers on uptake of iron, manganese, copper and Zinc (µg pot$^{-1}$)

**Maximum tillering stage**

| Treatment | Fe | | | | | Mn | | | | | Cu | | | | | Zn | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean |
| $P_0$ | 806 | 1172 | 1547 | 1935 | 1365 | 597 | 641 | 676 | 723 | 659 | 150 | 189 | 244 | 285 | 217 | 278 | 427 | 551 | 685 | 483 |
| $P_1$ | 1338 | 1460 | 1982 | 2329 | 1766 | 720 | 731 | 754 | 885 | 772 | 182 | 220 | 343 | 378 | 381 | 446 | 506 | 584 | 733 | 567 |
| $P_2$ | 1927 | 2857 | 2974 | 3571 | 2491 | 915 | 983 | 1020 | 929 | 962 | 271 | 302 | 403 | 481 | 364 | 556 | 603 | 707 | 884 | 687 |
| $P_3$ | 2365 | 3252 | 3436 | 4234 | 3017 | 1029 | 1067 | 1080 | 1271 | 1111 | 344 | 405 | 491 | 528 | 442 | 603 | 671 | 811 | 1076 | 790 |
| Mean | 1609 | 2174 | 2491 | 3017 | | 815 | 856 | 882 | 952 | | 236 | 279 | 370 | 418 | | 471 | 552 | 661 | 844 | |
| | | F | P | F x P | | | F | P | F x P | | | F | P | F x P | | | F | P | F x P | |
| SEm ± | | 50.3 | 50.3 | 100.6 | | | 12.85 | 12.85 | 25.71 | | | 8.38 | 8.38 | 16.77 | | | 12.24 | 12.24 | 24.48 | |
| CD (P = 0.05) | | 143.2 | 143.2 | 286.4 | | | 36.59 | 36.59 | 73.18 | | | 23.86 | 23.86 | NS | | | 34.85 | 34.85 | 69.71 | |

F - Fertilizer Level P - Poultry Manure Level

**Harvest**

| Treatment | Fe | | | | | Mn | | | | | Cu | | | | | Zn | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean |
| $P_0$ | 2085 | 2354 | 2988 | 3213 | 2660 | 876 | 871 | 925 | 982 | 913 | 408 | 601 | 869 | 1089 | 742 | 565 | 875 | 1256 | 1636 | 1083 |
| $P_1$ | 2642 | 3109 | 3712 | 4202 | 3416 | 1016 | 1129 | 1229 | 1233 | 1151 | 463 | 703 | 962 | 1202 | 833 | 761 | 1016 | 1406 | 2009 | 1298 |
| $P_2$ | 3388 | 4443 | 5126 | 5699 | 4664 | 1214 | 1219 | 1468 | 1565 | 1366 | 590 | 807 | 1056 | 1285 | 935 | 998 | 1215 | 1691 | 2195 | 1525 |
| $P_3$ | 4589 | 5664 | 6502 | 7059 | 5928 | 1419 | 1423 | 1526 | 1720 | 1522 | 632 | 799 | 1030 | 1344 | 951 | 1077 | 1304 | 1873 | 2545 | 1700 |
| Mean | 3176 | 3892 | 4557 | 5043 | | 1131 | 1160 | 1287 | 1375 | | 523 | 727 | 979 | 1230 | | 851 | 1102 | 1556 | 2096 | |
| | | F | P | F x P | | | F | P | F x P | | | F | P | F x P | | | F | P | F x P | |
| SEm ± | | 70.48 | 70.48 | 140.96 | | | 19.20 | 19.20 | 38.40 | | | 12.53 | 12.53 | 25.07 | | | 21.60 | 21.60 | 43.32 | |
| CD (P = 0.05) | | 200.70 | 200.70 | 401.40 | | | 54.67 | 54.67 | 109.35 | | | 35.68 | 35.68 | NS | | | 61.68 | 61.68 | 123.36 | |

F - Fertilizer Level P - Poultry Manure Level

Table 1 : Effect of poultry manure applied in combination with inorganic fertilizers on grain yield (g pot$^{-1}$) of rice

| | $F_0$ | $F_1$ | $F_2$ | $F_3$ | Mean |
|---|---|---|---|---|---|
| $P_0$ | 12.66 | 15.35 | 19.02 | 21.03 | 17.66 |
| $P_1$ | 16.85 | 17.91 | 20.90 | 23.27 | 19.52 |
| $F_2$ | 19.40 | 20.32 | 22.86 | 24.36 | 21.78 |
| $P_3$ | 21.74 | 24.52 | 24.33 | 28.80 | 24.36 |
| Mean | 17.01 | 19.73 | 21.74 | 24.85 | |
| | | SEm ± | CD (P = 0.05) | | |
| | Fertilizer Level (F) | 0.31 | 0.88 | | |
| | Poultry Manure Level (P) | 0.31 | 0.88 | | |
| | F X P | 0.61 | 1.75 | | |

27.2, 47.3 and 78.4 per cent over control, respectively. The increase in the yield and yield attributes may be due to more uptake of nutrients owing to their availability which resulted in better crop growth. The synergetic effects of combined use of NPK with poultry manure was also reported by Dubey and Verma (1999).

Addition of poultry manure (1 to 6 t ha$^{-1}$) with zero, half and full dose of fertilizers resulted an increase in uptake of macro as well as micronutrients (Tables 2 and 3). Uptake increased linearly with increasing levels of fertilizer and also poultry manure. Uptake of iron, manganese, copper and zinc was more at harvest than at maximum tillering stage due to more accumulation of dry matter at harvest and higher concentration of nutrients in the plant at added levels. Highest uptake of nutrients was recorded with recommended dose of fertilizer applied in combination with 6.0 tonnes of poultry manure per hectare. Increased absorption of micro nutrient cations may be due to complexing properties of poultry manure which prevented precipitation and fixation of these nutrients and keep them in soluble form (Sinha and Prasad, 1997 and Prasad *et al.,* 1984).

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(Received on 13-12-2001 and revised on 22-07-2003)

*The Andhra Agric.* J. **50** (3&4) : 242 - 245, 2003

# Conjuctive Use of Saline Drain Water and Good Quality Water

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## ABSTRACT

Irrigations with saline drain and good quality water were given at five important stages of maize crop viz., sowing, knee high stage, silking, flowering and milking. The results indicated that the treatment that received saline drain irrigation at silking and milking. The results indicated that the treatment that received saline drain irrigation at silking and milking stages produced 90% yield; taking the yield of treatment that received only good water irrigation as 100 per cent. The lowest yields of grain were recorded in the treatment that received only saline drain water throughout. The concentration of sodium in stalks was significantly the lowest in $T_5$ to $T_7$ (the treatments receiving more number of saline drain irrigations). The uptake of N,P,K and Na in grain as well as stalk though increased with no. of saline drain irrigations, the increase was not significant. No effect of treatments was observed on soil pH and available $P_2O_5$, however. EC ($dSm^{-1}$), available $K_2O$ and available Na increased with number of saline irrigations.

**Key words :** Conjunctive use, Saline

The key to effective use of saline irrigation water and salinity control is to provide proper amount of water to the plant at proper time. Good quality water for crop production purpose is a scarce resource in many places. There is a need to study the different ways and means of utilization of poor/marginal quality drain water that is available, as an alternate irrigation source in some areas in conjunction with good quality water. In this content an experiment was conducted to study the effect of use of saline drain water in conjunction with good quality water using maize as a test crop. A combination of saline drain and good quality water irrigations are given to crop at important stages *viz;* germination (sowing), knee high stage, silking, flowering and milking and their effect on yield uptake of nutrients and soil parameters are studied.

## MATERIAL AND METHODS

A field experiment was conducted at Agricultural College Farm, Bapatla on a black soil having of pH 8.2 and EC 0.32 ($dSm^{-1}$). Maize variety DHM - 103 was sown during *rabi* 2000 2001 with seven treatments replicated thrice in a simple randomized block design. The treatment details are as follows :

| Treatment | Irrigation stages | | | | |
|---|---|---|---|---|---|
| No. | At sowing | Knee high | Silking | Flowering | Milking |
| $T_1$ | GW | GW | GW | GW | GW |
| $T_2$ | GW | GW | GW | SDW | GW |
| $T_3$ | GW | GW | SDW | GW | SDW |
| $T_4$ | SDW | GW | GW | SDW | SDW |
| $T_5$ | SDW | GW | SDW | GW | GW |
| $T_6$ | GW | SDW | SDW | SDW | SDW |
| $T_7$ | SDW | SDW | SDW | SDW | SDW |

GW = Good quality water, SDW = Saline drain water

The state recommended fertilizer schedule for maize (120 : 60 : 30 kg/ha of N : $P_2O_5$ : $K_2O$) was adopted. Nitrogen was applied in three equal splits i.e. at sowing, knee high and silking stages. The pH and E.C. of good quality water varied from 7.0 to7.5 and 0.64 to 0.82 $dSm^{-1}$ whereas those of saline drain water ranged from 7.08 to 8.8 (pH) and 2.8 to 4.0 $dSm^{-1}$ (EC) during the crop growth period. Plant samples were drawn at harvest stage of the crop. Soil samples were also collected at harvest. Standards procedures were adopted in analysis of soil and plant for N,P,K and Na. The results discussed are average of two years.

## RESULTS AND DISCUSSIONS

### Yields

The highest grain yield of 7627 kg $ha^{-1}$ was recorded by $T_1$ (control received only good quality water at all stages of growth) while among the other treatments receiving saline drain water, $T_3$ (SDW at silking and at milking stages) recorded the highest seed yields (6623 kg $ha^{-1}$) followed by that of T2 (6433 kg $ha^{-1}$) which are all on par with each other (Table 1). This shows that $T_3$ recorded 87% of maximum yield (considering yields of control as 100 per cent) while $T_2$ recorded 84 per cent of maximum yield. This also implies that flowering stage of maize is more sensitive to salinity than that of silking and milking stages. Besides, by adopting irrigation schedule of $T_3$, 40 per cent of good quality water that is a scarce resource in many areas could be saved. These results were in conformity with those of Anonymous (1999) who reported the highest cotton kapas yield when three first irrigations were given as saline drain irrigations and rest with canal water when planted during 3rd week of June. Sharma (1999) too reported that application of canal water (C) and alternate use of tube well (T) water (saline) increased jowar (forage) yield by 12% and 9.3% and rice yield by 17.4 and 10.2%, respectively during two years of experimentation, compared to T alone at Bhaini Majra farm, Khaital. Similar observations were made by Nayak *et al.*, (2001), who reported mustard yield was on par with control (only good water irrigation) when given saline irrigation at branching stage of crop.

Stalk yield was also influenced by saline drain water irrigation (Table 1). The treatments $T_2$ and $T_3$ recorded 97.6 and 93% of maximum straw yields i.e., $T_1$ (17020 $kgha^{-1}$), respectively. The lower yield of stalk as well as grain were recorded by $T_7$ (13287 and 5680 kg $ha^{-1}$, respectively), which received saline drain irrigations throughout.

### Uptake of nutrients

The uptake of N,P,K and Na in grain and stalks are presented in Table 2. The uptake of N by grain reduced with increasing number of saline drain irrigations. The highest being recorded by $T_1$ (126.4 kg $ha^{-1}$). The uptake of P,K and Na by grain was however unaffected. No significant effect of treatments on nutrient uptake of stalks was observed except that of nitrogen. The sodium concentration, which was significant in stalks, was not reflected in its uptake. The lowest N,P,K and Na uptake in both grain and stalks, was not reflected in its uptake. The lowest N,P,K and Na uptake in both grain and stalks was observed by $T_7$, the treatment that received only saline drain water for irrigation throughout the experiment. Such low uptake values by $T_7$ could be due to very poor dry matter production resulting in low uptake of nutrients.

### Soil parameters

The effect of saline water / good quality water on soil properties is given in Table 3. It

Table 1 : Effect of conjunctive use of SDW and good quality water on grain and stalk yields of maize crop.

| Treatments | Grain yield kg $ha^{-1}$ | Stalk yield kg $ha^{-1}$ |
|---|---|---|
| $T_1$ | 7627 | 17020 |
| $T_2$ | 6433 | 16613 |
| $T_3$ | 6623 | 15960 |
| $T_4$ | 5827 | 16177 |
| $T_5$ | 6003 | 14320 |
| $T_6$ | 5867 | 14163 |
| $T_7$ | 5680 | 13287 |
| S.Em (±) | 195 | 629 |
| C.D (0.05) | 425 | 1370 |
| C.V % | 3.8 | 5.01 |

Table 2 : Effect of conjunctive use of SDW and good quality water on uptake of NPK and Na in grain and stalk in kg $ha^{-1}$

| Treatments | N uptake | | P uptake | | K uptake | | Na uptake | |
|---|---|---|---|---|---|---|---|---|
| | grain | stalk | grain | stalk | grain | stalk | grain | stalk |
| $T_1$ | 126.40 | 140.76 | 42.0 | 27.0 | 50.0 | 148 | 4.0 | 48.0 |
| $T_2$ | 99.90 | 126.26 | 34.0 | 26.0 | 38.0 | 139 | 4.0 | 53.0 |
| $T_3$ | 105.10 | 144.43 | 35.0 | 23.0 | 43.0 | 134 | 4.0 | 53.0 |
| $T_4$ | 93.70 | 118.57 | 24.0 | 21.0 | 37.0 | 146 | 4.0 | 52.0 |
| $T_5$ | 97.10 | 103.10 | 32.0 | 20.0 | 38.0 | 122 | 4.0 | 50.0 |
| $T_6$ | 92.50 | 101.55 | 28.0 | 20.0 | 36.0 | 127 | 4.0 | 50.0 |
| $T_7$ | 86.60 | 95.97 | 29.0 | 16.0 | 36.0 | 107 | 4.0 | 48.0 |
| S.Em (±) | 8.106 | 4.68 | | | | | | |
| C.D | 17.663 | 10.20 | NS | NS | NS | NS | NS | NS |
| C.V at 5% | 9.91 | 5.01 | 11.86 | 14.29 | 5.88 | 6.480 | 8.68 | 11.860 |

could be inferred that there is no significant influence of treatments on pH and available $P_2O_5$ contents of soil at harvest of crop. Regarding other parameters the electrical conductivity ($dSm^{-1}$) of soils in $T_1$ and $T_2$ were on par with each other and so also is the case with that of $T_4$ and $T_5$. It could be observed that there is an increase in E.C with increasing number of saline irrigations. Such increases were in soil salinity due to irrigations with saline water was also reported by Anonymous (1999) and Nayak (2001). The content of available N though differed significantly among treatments, the highest was observed at harvest of crop by $T_1$ and the least in that of $T_6$ and $T_7$. It implies that the level of N in $T_1$ is low comparatively owing to its greater utilization by crop for producing comparatively higher yields. The available phosphorus content in soil was not influenced by type of irrigations. The content of available $K_2O$ decreased from $T_1$ (549.33 kg $ha^{-1}$) to $T_6$ (3392 kg $ha^{-1}$) indicating lesser levels with increasing number of saline irrigations. The highest content of available sodium was

Table 3 : Effect of conjuctive use of SDW and good quality water on available N, $P_2O_5$, $K_2O$, Na, pH and EC of soil samples (surface) at harvest of crop

| Treatments | pH | ECe (dSm$^{-1}$) | Available nutrient (kg ha$^{-1}$) | | | |
|---|---|---|---|---|---|---|
| | | | N | $P_2O_5$ | $K_2O$ | Na |
| $T_1$ | 8.25 | 0.37 | 348.50 | 15.90 | 549.33 | 3090 |
| $T_2$ | 8.31 | 0.37 | 342.00 | 15.98 | 529.60 | 3392 |
| $T_3$ | 8.26 | 0.39 | 335.10 | 15.89 | 527.60 | 3131 |
| $T_4$ | 8.24 | 0.41 | 350.22 | 15.68 | 521.80 | 3626 |
| $T_5$ | 8.25 | 0.41 | 363.95 | 15.21 | 492.87 | 3093 |
| $T_6$ | 8.32 | 0.45 | 335.61 | 15.06 | 462.87 | 3320 |
| $T_7$ | 8.32 | 0.46 | 335.39 | 15.03 | 476.87 | 3624 |
| S.Em (±) | | 0.026 | 9.749 | | 16.07 | 207.7 |
| C.D | NS | 0.056 | 21.243 | NS | 35.016 | 452.5 |
| C.V at 5% | 7.80 | 5.730 | 3.470 | 3.74 | 3.870 | 7.65 |

recorded by $T_4$ (3626 kg ha$^{-1}$) followed by $T_7$ (3624 kg ha$^{-1}$). The $T_2$ (3392 kg ha$^{-1}$) and $T_6$ (3320 kg ha$^{-1}$) which were these are all on par with each other. The lowest content of available, Na was observed by $T_1$ (3090 kg ha$^{-1}$); the treatment, which received only good water irrigations.

## Conclusions

The use of saline irrigation water for crop production in maize indicated that drain water irrigations at silking and milking stages produced grain yields on par with that of $T_1$ (completely good water irrigation). The grain and stalk yield 87 and 93 per cent of maximum yields, respectively could be achieved by replacing two irrigations with saline drain source, besides, 40 percent of good quality irrigation water, which is a scarce resource in many areas could be saved. Use of saline water continuously results in accumulation of Na in soil and also plant parts (especially stalks). It could be concluded that in areas of limited availability of good water for irrigation saline drain water could be used efficiently when used for irrigation at silking and milking stages by maize, without significant deterioration in soil properties.

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(Received on 27-03-2002 and revised on 10-01-2003)

*The Andhra Agric.* J. **50** (3&4) : 246 - 249, 2003

# Influence of Poultry Manure Along with Different Indigenous Plant Materials on Nutrient Availability and Yield of Rice

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## ABSTRACT

A pot culture experiment was conducted to study the influence of poultry manure along with different indigenous plant materials on nutrient availability and yield of rice grown in a sandy loam soil during *rabi* 2000. Poultry manure from 0 to 3 t ha$^{-1}$ with neem cake, mustard cake and tabacco leaf residues @ 1/5 of poultry manure by weight increased the grain yield of rice. Available N,P,K and DTPA extractable Fe, Mn, Cu, and Zn increased with addition of poultry manure along with indigenous plant materials. Soil urease activity was more at maximum tillering stage than at harvest and increased with manure application.

**Key words :** Poultry manure, indigenous plant materials, urease activity.

Poultry manure is a good source of nutrients (N, P, K, S, Ca, Mg, Zn, Cu, Fe and Mn). Nitrogen excreted in poultry manure is in the form of uric acid which can be converted into urea and ammonia if temperature, pH and moisture are adequate for microbial activity and subjected to heavy losses. Nutrient management assumes greater importance in coastal sandy soils with some intensive cropping sequences for sustaining the crop productivity as these soils are nutritionally poor. However, in coastal area with well developed poultry industry, it becomes imperative to utilize the poultry waste as an alternative source of plant nutrients. However, there is a need to minimize the losses of nutrients through slow release and inhibiting the nitrification process. Since the poultry manure is a bulky organic manure, using chemicals for slow release and nitrification inhibition is expensive. Therefore there is also a need to evaluate some of the indigenous plant materials which can inhibit and reduce the losses of nutrients in poultry manure. Hence an experiment was conducted to study the affect of poultry manure in combination with neem cake, mustard cake and tobacco leaf residues on nutrient availability and yield of rice grown in a sandy loam soil.

The soil used has pH 7.8, EC 0.71 dSm$^{-1}$, OC 0.32 % and contains 247.4, 33.6, 290.5 kg ha$^{-1}$ NPK and 8.7, 9.0, 0.93 and 0.96 ppm of Fe, Mn, Cu and Zn, respectively. The texture in sandy loam with 11.7 µg g$^{-1}$ soil h$^{-1}$ urease activity.

## MATERIAL AND METHODS

Surface soil collected, processed was taken into 10 kg earthen pot and mixed thoroughly with 0, 1, 2, and 3 t ha$^{-1}$ poultry manure and indigenous plant materials @ 1/5 of the poultry manure on weight basis with 75% recommended dose of fertilizers for all the treatments uniformly. The entire dose of $P_2O_5$, $K_2O$ and half the dose of nitrogen were applied as basal dose. The balance of nitrogen was applied at maximum tillering stage in the form of urea. Thirty days old seedlings of paddy var. MTU 1010 was transplanted into three

Table 1 : Effect of poultry manure applied in combination with indigenous plant materials on available nitrogen, phosphorus and potassium (kg ha$^{-1}$) of soil at harvest

| Poultry manure | Nitrogen (kg ha$^{-1}$) Indigenous plant materials |  |  |  | Phosphorus (kg ha$^{-1}$) Indigenous plant materials |  |  |  | Potassium (kg ha$^{-1}$) Indigenous plant materials |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Neem cake | Mustard cake | Tobacco residues | Mean | Neem cake | Mustard cake | Tobacco residues | Mean | Neem cake | Mustard cake | Tobacco residues | Mean |
| $m_0$ | 210.1 | 216.3 | 207.0 | 211.1 | 17.5 | 20.5 | 1.0 | 19.0 | 246.4 | 273.4 | 266.9 | 262.2 |
| $m_1$ | 288.0 | 273.8 | 267.2 | 276.2 | 36.2 | 32.1 | 28.9 | 32.4 | 301.2 | 273.9 | 274.9 | 283.3 |
| $m_2$ | 312.6 | 298.8 | 290.2 | 300.5 | 41.0 | 38.3 | 36.2 | 38.5 | 332.7 | 304.5 | 288.2 | 307.8 |
| $m_3$ | 337.7 | 326.5 | 322.2 | 328.8 | 47.6 | 44.8 | 42.5 | 45.0 | 347.7 | 309.5 | 298.1 | 318.4 |
| Mean | 287.1 | 278.8 | 271.6 |  | 35.6 | 33.9 | 31.6 |  | 307.0 | 289.8 | 282.0 |  |
|  |  | A | B | A x B |  | A | B | A x B |  | A | B | A x B |
| SEM ± |  | 1.66 | 1.43 | 2.87 |  | 0.62 | 0.54 | 1.08 |  | 6.58 | 5.70 | 11.42 |
| CD(P=0.05) |  | 4.86 | 4.20 | 8.41 |  | 1.83 | 1.58 | 3.17 |  | 19.26 | 16.68 | 33.37 |

A - Poultry manure level B - Indigenous plant material

Table 2 : Effect of poultry manure applied in combination with indigenous plant materials on DTPA extractable iron, manganese, copper and zinc (ppm) of soil at harvest

| Poultry manure | Fe (ppm) Indigenous plant materials |  |  |  | Mn (ppm) Indigenous plant materials |  |  |  | Cu (ppm) Indigenous plant materials |  |  |  | Zn (ppm) Indigenous plant materials |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Neem cake | Mustard cake | Tobacco residues | Mean | Neem cake | Mustard cake | Tobacco residues | Mean | Neem cake | Mustard cake | Tobacco residues | Mean | Neem cake | Mustard cake | Tobacco residues | Mean |
| $m_0$ | 5.54 | 6.71 | 6.39 | 6.21 | 6.07 | 6.04 | 6.27 | 6.12 | 0.76 | 0.81 | 0.82 | 0.80 | 0.51 | 0.64 | 0.51 | 0.56 |
| $m_1$ | 8.22 | 9.06 | 8.69 | 8.66 | 8.54 | 8.34 | 8.41 | 8.43 | 0.93 | 0.82 | 0.80 | 0.85 | 1.05 | 1.00 | 0.80 | 0.95 |
| $m_2$ | 9.62 | 10.24 | 9.57 | 9.81 | 9.25 | 9.44 | 9.12 | 9.27 | 0.98 | 0.93 | 0.87 | 0.93 | 1.32 | 1.18 | 1.06 | 1.18 |
| $m_3$ | 10.23 | 11.46 | 10.17 | 10.62 | 10.14 | 9.92 | 9.41 | 9.82 | 1.21 | 1.00 | 1.01 | 1.07 | 1.40 | 1.31 | 1.21 | 1.31 |
| Mean | 8.40 | 9.37 | 8.70 |  | 8.50 | 8.43 | 8.30 |  | 0.97 | 0.89 | 0.87 |  | 1.07 | 1.03 | 0.89 |  |
|  |  | A | B | A x B |  | A | B | A x B |  | A | B | A x B |  | A | B | A x B |
| SEM ± |  | 0.14 | 1.12 | 0.25 |  | 0.23 | 0.20 | 0.40 |  | 0.01 | 0.01 | 0.02 |  | 0.02 | 0.02 | 0.04 |
| CD(P=0.05) |  | 0.42 | 0.37 | -- |  | 0.67 | -- | -- |  | 0.05 | 0.04 | 0.08 |  | 0.07 | 0.06 | 0.13 |

A - Poultry manure level B - Indigenous plant material

Table 3 : Effect of poultry manure applied in combination with indigenous plant materials on yield of rice

| Poultry manure | Grain yield (g pot$^{-1}$) Indigenous plant materials | | | | Straw yield (g pot$^{-1}$) Indigenous plant materials | | | |
|---|---|---|---|---|---|---|---|---|
| | Neem cake | Mustard cake | Tobacco residues | Mean | Neem cake | Mustard cake | Tobacco residues | Mean |
| $m_0$ | 20.4 | 20.8 | 21.0 | 20.7 | 29.3 | 29.4 | 31.3 | 30.0 |
| $m_1$ | 28.9 | 27.2 | 25.3 | 27.1 | 36.7 | 35.1 | 33.6 | 35.1 |
| $m_2$ | 33.7 | 34.5 | 30.2 | 32.8 | 41.3 | 44.2 | 38.9 | 41.4 |
| $m_3$ | 39.0 | 38.3 | 34.6 | 37.3 | 47.4 | 48.1 | 43.0 | 46.1 |
| Mean | 30.5 | 30.2 | 27.8 | | 38.7 | 39.2 | 36.7 | |
| | | A | B | A x B | | A | B | A x B |
| SEM ± | | 0.28 | 0.25 | 0.50 | | 1.07 | 0.92 | 1.85 |
| CD(P=0.05) | | 0.84 | 0.73 | 1.46 | | 3.13 | -- | -- |
| | | | A - Poultry manure level | | | | B - Indigenous plant material | |

Table 4 : Effect of poultry manure applied in combination with indigenous plant materials on soil urease activity ($\mu$g of $NH_4^+$ g$^{-1}$ soil h$^{-1}$)

| Poultry manure | Maximum tillering stage Indigenous plant materials | | | | Harvest Indigenous plant materials | | | |
|---|---|---|---|---|---|---|---|---|
| | Neem cake | Mustard cake | Tobacco residues | Mean | Neem cake | Mustard cake | Tobacco residues | Mean |
| $m_0$ | 12.6 | 15.1 | 15.8 | 14.5 | 11.4 | 13.7 | 12.2 | 12.4 |
| $m_1$ | 14.5 | 15.5 | 15.9 | 15.2 | 12.2 | 14.3 | 13.7 | 13.4 |
| $m_2$ | 16.4 | 17.7 | 18.3 | 17.4 | 14.9 | 15.8 | 16.3 | 15.7 |
| $m_3$ | 19.8 | 20.1 | 21.5 | 20.4 | 16.3 | 17.8 | 18.4 | 17.5 |
| Mean | 15.8 | 17.1 | 17.8 | | 13.7 | 15.4 | 15.2 | |
| | | A | B | A x B | | A | B | A x B |
| SEM ± | | 0.12 | 0.11 | 0.22 | | 0.12 | 0.10 | 0.21 |
| CD(P=0.05) | | 0.37 | 0.32 | 0.65 | | 0.37 | 0.31 | 0.64 |
| | | | A - Poultry manure level | | | | B - Indigenous plant material | |

replications of two sets, one set of which was removed at maximum tillering stage and the other continued upto harvest. Plant and soil samples collected at both the stages were analysed by adopting standard procedures.

## RESULTS AND DISCUSSION

Application of poultry manure from 0 to 3 t ha$^{-1}$ in combination with indigenous plant materials increased the grain yield of rice (Table 3) over control. The increase in the grain and straw yields with the addition of poultry manure is mainly due to mineralization of manure which released more nutrients into soil solution and facilitated for higher uptake resulted in the higher yields. Similar results were also reported by Singh *et al.* (1999).

Available N, P and K determined in the soils collected at harvest recorded an increase over control (Table 1). The increase in the available nutrients might be due to mineralization of organically bound nutrients and exchange reactions contributing increased availability of nutrients in the soil as observed by Panneerselvam *et al.* (1999).

Among the different plant materials used neem cake was found to be slightly superior to mustard cake and tobacco residues. The superiority of neem cake might be due to the contribution of the nitrogen from the neem cake itself and better inhibition of nitrification due to nimbidin and sulphur present in it (Patil, 1972). Significant increase (Table 2) in the DTPA extractable Fe, Mn, Cu and Zn was because of complexing properties of organic manure which prevents precipitation and fixation otherwise and keep them in soluble form, in addition itself acting as a good source of these nutrients. Similar results of increased availability of micronutrients was also reported by Jackson and Miller (2000).

Soil urease activity increased with the addition of poultry manure (Table 4). The increase in the enzyme activities at added levels of poultry manure might be due to increase in the organic matter content and microbial population brought about by plants. Alteration of enzyme activities due to addition of organic residues was reported by Reddy and Mishra (1983).

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(Received on 25-04-2002 and revised on 22-07-2003)

*The Andhra Agric.* J. **50** (3&4) : 250 - 254, 2003

# Impact of Cement Dust Pollution on Physico - Chemical Properties of Soil

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## ABSTRACT

Effect of cement dust pollution on physicochemical properties of polluted soils near the cement industry Polluted Soil I (soil at the base of industry) and Polluted Soil II (from 2km) were assessed and compared with Unpolluted soil collected 4km away from cement industry. Both polluted soil samples underwent significant changes in majority of measured physico - chemical characteristics. Further, all these changes are intensified in polluted soil-I and II. Increased pH, electrical conductivity, apparent density, specific gravity with decreased per cent pore space and water holding capacity may inturn effect ecosystem. Increased inorganic nutrients like Na, K, Ca, Mg and P in the polluted soils may play a role in osmotic pressure and in ion and heavy metal absorption by plant and also responsible for enhanced pH and electrical conductivity of the polluted soils. This brand of cement dust pollution does not cause any change regarding soil Ni and Cd contents, significant increased in Cr was found in both polluted soils, whereas significant increase of Al in polluted soil I. Thus, all the altered physicochemical parameter of polluted soils are in the direction of decreased microbial population and soil fertility.

**Key words :** Cement dust, soil pollution, soil physicochemical properties.

Cement dust is an important particulate pollutant near cement factories and construction sites (Arslan *et al.*, 1990; Shukla *et al.*, 1990). Even though soil acts as a physical, chemical and biological filter to minimize the pollution, there are some materials that are difficult or impossible to decompose. Accumulation of such material can pollute the soil affecting the qualitative and quantitative composition of soil organisms and fertility. So soil pollution alter the economy of the country. For nation like India where majority depends on agriculture, preservation of original nature of the soil from getting polluted is very essential, for which assessment of pollution effect is essential.

As less information is available about the effect of cement dust pollution on soil physicochemical properties, further, the impact of cement pollution may vary from one geographical area to another because of variation in the type of raw materials used for manufacture of the cement. So an attempt was made in the present study to find out the effects of cement dust pollution on physicochemical properties of soil.

## MATERIAL AND METHODS

The present study is conducted in soil samples collected from Panyam Cements and Mineral Industries limited founded in 1955 located at Bugganipalli near Bethamcharla, Kurnool district, Andhra Pradesh, India.

Composite soil samples were collected near the base of the cement industry, 2 km and 4 km from the industry. Soil collected at the base of the cement factory and at 2 km distance from the factory are considered as cement dust polluted soils (I and II) and soil collected at

4 km. distance from the cement factory is considered as control non-polluted soil basing on the criteria laid by Shukla *et al.* (1990). Soil samples were packed in polythene covers, after air drying, sieved through 2mm sieve and refrigerated in plastic bags till used.

Physicochemical properties of soil samples were determined following standard procedures. Soil texture i.e., mineral matter of soil samples such as sand, silt and clay content was analysed with use of different sizes of sieves by the method of Alexander (1961). Physical single values constants like apparent density, absolute density, per cent pore space and percentage of water holding capacity (WHC) were determined. The pH and electrical conductivity of soil samples were measured with the help of Elico pH meter and conductivity bride respectively following the method of Jackson (1973). Organic carbon, exchangeable cations; sodium, and potassium, calcium and magnesium and available phosphorous of soil samples were determined by the method of Walkley-Black (Jackson, 1971 and 1973; Black, 1965 and Olsen *et al.* 1954). Heavy metals like Fe, Ni, Al and Cd contents of the soil were determined by using Perkin-Elmer-272 atomic absorption spectrophotometer.

## RESULTS AND DISCUSSION

Both soil sample polluted with cement dust (sample I & II) underwent changes in all measured parameters in comparison to control soil (Table) Further, all these changes are intensified in polluted soil I compared to polluted soil II.

All three soil samples are found to be of sandy loam type according to the per cent of soil particles (Alexander, 1961). Regarding physical single value constants; apparent density, absolute density were found to be increased in both polluted soil than control soil. Percentage of pore space and percentage of water holding capacity were decreased as we move near to the factory. Decrease in water holding capacity was more pronounced in polluted soil I than polluted soil II. Changes in these physical properties compared to control soil were attributed to occupation of cement dust in the voids of the soil in the polluted area. As at the base of factory has more rate of cement dust fall there is maximum reduction in the WHC and percentage pore space in polluted soil-I compared to polluted soil-II. Furher, these results are coincided with earlier reports of Parthasarathy *et al.* (1975) and Madhu Singh (1992).

Both the polluted soils showed an increase in soil electrical conductivity and pH compared to control soil. Increased electrical conductivity indicates increased concentrations of soluble salts in cement dust polluted soils. These results were in conformity with studies of Salem *et al.* (1990) and Shukla *et al.* (1990). The cement kiln dust contains a large amount of alkaline soluble calcium salts and nearly 8% of the dust was reported to be lime by Prasad *et al.* (1991). Thus, the increased soil pH in the cement dust polluted soils might have been caused by the hydroxides of calcium and aluminium formed during hydration. Parthasarathy *et al.* (1975) reported that cement dust particles, were heavy and settle down in the immediate vicinity of the factory thus resulted in more dust deposition near the factory. Thus, soil pH and electrical conductivity increased as the rate of cement dust deposition increased, whereas, Singh and Rao (1968) reported that the pH increase was not proportional to the amount of cement dust added to the soil due to buffering capacity of soils to certain extent. Thus buffering capacity of polluted soil-II and due to less deposition of cement dust in these areas might have resulted in no significant increase in the soil pH compared to control soil.

The increased concentration of organic carbon of polluted soil-I (0 km) can be attributed to the composition of the cement dust as it contains some unburnt carbon (Sai *et al.*, 1987). Singh and Rao (1968) revealed a direct relationship between organic carbon of soils to their pH values. It is very likely that in soils of higher pH, the microbial activity is reduced resulted in decreased organic matter decomposition.

Increased concentrations of exchangeable Na, K, Ca, Mg and available P was observed in both the polluted soil compared to the control soil. Further, these changes are more prominent in polluted soil-I supporting the earlier findings of Szostek and Marian (1987). Calcium content of the soil plays an essential role in cation absorption and inhibits absorption of heavy metals by plant root (Kawasaki and Moritsugu, 1986). Calcium silicate ($CaOSiO_2$) and Calcium aluminate ($CaO.Al_2O_3$) present in cement dust form colloidal gels, which after crystallization and solidification develop into a hard crust (Pathmanabhan *et al.*, 1979). Such a crust will make surfaces of soil and plant compact, rendering them more or less impervious to water and thereby upsetting their physicochemical properties. In long run, the increase in concentrations of Ca will make the soil alkaline, thus raising the pH and osmotic pressure of soil to undesirable levels.

Increased exchangeable $Na^+$ has received importance as it exerts effect in promoting poor physical conditions of soil and bringing about unbalanced nutrition of plants. $Na^+$ dominates in soil only in alkaline range. Soils with high exchangeable Na are readily deflocculated and puddle at even low moisture content.

The increased available phosphorus in polluted soils can also be due to the high exchangeable Na in these soils. Under this Na dominant conditions phosphorus solubility increases rapidly because of the formation of soluble sodium phosphate compounds. Even though, there is a increase in available phosphorus in polluted soils it is less readily assimilated because of alkaline conditions (Hayner and Ludecke, 1981).

Due to the increased levels of available Na, K, Ca, Mg in cement dust polluted fields, the osmotic pressure of soil solution may be greater than the root cells, which may results in reverse flow of water from roots to soil. Thus, resulted in less vegetation and decreased growth of crop in the polluted fields compared to control unpolluted fields.

Heavy metals like Ni, Cd, Al and Cr in soil samples are analysed in these soil samples and data was represented in table. There was no significant change in the soil Ni concentrations in the polluted soils compared to control soil. Cd concentrations in these three soil samples were found to be below detectable level. Whereas, significant increase in concentrations of Al and Cr were observed in the polluted soils compared to control soil. Al and Cr are reported to have inhibitory effect on N-mineralization and nitrification (Liang and Tabatabai, 1978.) The alkalinity and high concentrations of exchangeable Ca in polluted soils may decrease the severity of Al toxicity.

Cr at high concentrations completely inhibits germination (Guruprasad rao and Nanda Kumar, 1981) decreases chlorophyll synthesis (Aravind Bharathi *et al.*, 1979). Thus the increased Cr content in the polluted soils may be one of the factors for decreased vegetation and growth of plants. Thus, all these altered factors in polluted soils are in the direction of decreased microbial population and soil fertility affecting crop growth and yield.

Table : Physico - chemical characteristics of soil samples polluted with / without cement dust.

| Parameters | Distance approximately from Cement factory | | |
|---|---|---|---|
| | 0 km (Polluted Soil-I) | 2 km (Polluted Soil-II) | 4 km (Control Soil) |
| **Soil Texture** | | | |
| Sand (%) | 64.34 | 69.40 | 80.10 |
| Silt (%) | 30.83 | 25.93 | 16.60 |
| Clay (%) | 4.33 | 4.67 | 3.30 |
| **Physical Single value constants** | | | |
| Apparent density g/cc | 1.57 | 1.33 | 1.24 |
| Absolute density g/cc | 2.72 | 2.41 | 2.22 |
| Percentage pore space | 40.75 | 45.95 | 50.03 |
| Water holding capacity (%) | 26.74 | 41.45 | 49.53 |
| pH | 9.4 | 7.34 | 7.04 |
| Electrical Conductivity (µmhoS / cm) | 539.3 | 280 | 200 |
| Percent Organic carbon | 1.15 | 0.576 | 0.599 |
| **Inorganic Nutrients** | | | |
| Exchangeable Sodium (ppm) | 398.15 | 301.75 | 266.49 |
| Exchangeable Potassium (ppm) | 303.77 | 201.71 | 183.72 |
| Exchangeable Calcium (ppm) | 2155.04 | 1571.49 | 1253.62 |
| Magnesium (meq/100g soil) | 4.86 | 4.03 | 2.54 |
| Phosphorus (µg/g soil) | 8.47 | 6.37 | 4.56 |
| **Heavy metals (mg/100gm soil)** | | | |
| Aluminium | 2753.0 | 2197.0 | 2129.0 |
| Chromium | 6.631 | 6.763 | 5.121 |
| Nickel | 2.47 | 2.45 | 2.51 |
| Cadmium (Below detectable level) | < 0.982 | < 0.99 | < 0.96 |

Each value is an average of triplicates.

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(Received on 06-09-2003 and revised on 08-01-2004)

*The Andhra Agric.* J. **50** (3&4) : 255 - 257, 2003

# Foliar Application of Micronutrients on Growth and Yield of Indian Mustard (*Brassica Juncea* (L.) Czernj & Cosson)

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## ABSTRACT

The need for application of micronutrients is becoming key in oilseeds production in current day agriculture as Indian soils showing deficiencies of these elements. Field study revealed that seed and stover yields were significantly increased by the application of B and Mo and to a lesser extent with Zn. Foliar application of 1 ppm borax +0.1 % ammonium molybdate improved seed yield of mustard by 24 per cent over recommended NPK alone. Significant improvement in yield attributes was noticed by the application of B+ Mo, Zn + B + Mo and B alone along with recommended NPK.

**Key words :** Micronutrients, Foliar application, Indian mustard, Zinc, Boron, Molybdenum, FYM.

India accounts for about 14.0 per cent of the world's oil seeds area and 8.0 per cent of oil seeds production with an area of 26.4 m.ha, and with an average productivity of 815 kg ha-1 ("The Hindu" Survey of Indian Agriculture, 2002). Indian mustard (*Brassica juncea* (L.) Czernj & Cosson) is an important oil seed crop in India which gained importance recently in Andhra Pradesh as a non-traditional oil seed crop. To increase or sustain the productivity of mustard, there is a need for supplementation of micronutrient over and above the recommended NPK and FYM alone. Application of micronutrients through foliar spray become important for their efficient utilisation and better performance of the crop. The present experiment, therefore, was taken up to study the response of Indian mustard to foliar application of Zn, B and Mo in improving yield attributes and yield.

## MATERIAL AND METHODS

A field trial was conducted during *rabi 2001* at Agricultural College Farm, Bapatla on clay loam soil that was slightly alkaline reaction (pH 7.7), medium in organic carbon content (0.65%), 278 kg ha$^{-1}$ of available N, 14 kg ha$^{-1}$ of available P, 608 kg ha$^{-1}$ of available K, 2.8 ppm of available Zn (sufficient level), 0.49 ppm of available Boron and 0.06 ppm of available Mo (deficient levels). The experiment was laid out in randomized block design with 10 treatments replicated three times. The treatment combination consisted of individual application (Zn, B and Mo), combined application (Zn + B, B + Mo, Zn + Mo, Zn + B + Mo) and recommended NPK alone and FYM alone (farmer's traditional practice) and FYM along with the three micronutrients. Zn, B and Mo were sprayed as 0.5 per cent $ZnSO_4$, 1.0 ppm borax and 0.1 per cent ammonium molybdate respectively. Spray fluid at a rate of 500 L ha$^{-1}$ was used for foliar spray.

## RESULTS AND DISCUSSION

The yield components like number of siliquae plant$^{-1}$, seeds siliqua$^{-1}$ and 1000 - seed weight were significantly increased by B, Mo and to a lesser extent with Zn (Table 1). The crop

Table 1 : Plant height, yield components and yield of Indian mustard as affected by foliar application of micronutrients

| Treatment | Plant height (cm) | Siliquae plant$^{-1}$ | Seeds siliqua$^{-1}$ | 1000 - seed weight (g) | Seed yield (kg ha$^{-1}$) | Stover yield (kg ha$^{-1}$) | Mean oil content (%) |
|---|---|---|---|---|---|---|---|
| Recommended NPK | 143.6 | 186.0 | 10.7 | 2.7 | 1020 | 2364 | 28.6 |
| Zn * | 145.0 | 190.7 | 11.3 | 2.9 | 1038 | 2478 | 30.7 |
| B* | 149.9 | 190.3 | 12.7 | 2.1 | 1137 | 2641 | 31.3 |
| Mo* | 144.4 | 190.0 | 11.3 | 2.9 | 1083 | 2581 | 28.7 |
| Zn + B* | 169.7 | 198.7 | 12.7 | 3.3 | 1047 | 2184 | 31.0 |
| B + Mo* | 170.7 | 220.8 | 13.3 | 3.9 | 1349 | 2710 | 32.2 |
| Zn + Mo* | 165.7 | 187.3 | 12.0 | 2.7 | 1011 | 1850 | 29.5 |
| Zn + B + Mo* | 176.3 | 245.0 | 13.3 | 3.4 | 1309 | 2770 | 33.5 |
| FYM (5 t ha$^{-1}$) | 133.3 | 161.3 | 8.7 | 2.7 | 595 | 1640 | 29.0 |
| FYM + Zn + B+ Mo | 135.0 | 176.7 | 8.7 | 2.7 | 659 | 1700 | 29.3 |
| SEm (±) | 2.9 | 8.2 | 0.8 | 0.2 | 99.2 | 132 | -- |
| CD (P = 0.05) | 15.5 | 24.4 | 2.5 | 0.6 | 294 | 391 | -- |

- Treatments with (*) also received recommended NPK.
- Zn, B and Mo were sprayed as 0.5 per cent $ZnSO_4$, 1.0 ppm borax ad 0.1 per cent ammonium molybdate.

was found responsive to B and Mo than Zn as the soil was initially sufficient in Zn. Application of B + Mo and Zn + B + Mo along with recommended NPK increased the seed yield by 24 and 22 per cent respectively, over recommended NPK alone. Significant improvement in yield attributes due to B and Mo application was also reported by Dravid and Goswami (1988), Biswas *et al.* (1995) and Jain and Sharma (2000). Maximum stover yield was obtained by the foliar application of Zn + B + Mo over the recommended NPK alone. There was an improvement in yield attributes with combination treatment over that of their individual form of application. The contribution of boron in development and differentiation of tissues, and the association of molybdenum with oxidation reduction reactions especially in the synthesis of fatty acids (Cripps, 1956) might have been responsible for improvement in yield attributes and yield. Application of zinc did not show marked response in improving yield due to its sufficient levels in soil.

Mean oil content values recorded were highest due to the application of Zn + B + Mo perhaps due to the synergistic effect of the combination of these micronutrients. An increase in oil content due to the application of micronutrients was also reported by Shukla *et al.* (1983) and Abhijit Saha *et al.* (1999). Oil yield values also recorded were the highest with B + Mo followed by Zn + B + Mo along with recommended NPK. Almost all yield attributes recorded showed inferior values in FYM applied treatments (Table 1).

Overall, the results of the study indicated the need for application of B and Mo over the recommended NPK for increasing the productivity of mustard on clay loam soils.

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(Received on 11-02-2003 and revised on 15-11-2003)

*The Andhra Agric. J.* **50** (3&4) : 258 - 262, 2003

# Effect of Nitrogen and Phosphorus on Growth, Yield and Quality of French Bean (*Phaseolus vulgaris* L.)

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## ABSTRACT

An experiment was conducted to study the effect of nitrogen and phosphorus on growth, yield and quality of french bean cv. Arka Komal at S.V. Agricultural College, Tirupati during *rabi*, 1998. The treatments consist of four levels of nitrogen (0,50,100 and 150 kg ha$^{-1}$), three levels of phosphorus (0,40 and 80 kg ha$^{-1}$) and their combinations. Growth parameters like plant height, leaf area and leaf area index were increased with increase in levels of nitrogen and phosphorus at all stages of crop growth. The interaction between $N_{150}$ and $P_{80}$ was significant at all stages for plant height, leaf area, leaf area index and dry matter production.

**Key words :** Nitrogen, Phosphorus, French Bean.

The yield attributing characters like number of pods per plant, pod weight and pod length increased significantly with increase in levels of nitrogen upto 100 kg ha$^{-1}$ but the response to phosphorus application was not significant in case of pod weight and pod length. Pod yield was increased with increase in level of nitrogen upto 100 kg ha$^{-1}$ and phosphorus upto 80 kg ha$^{-1}$. Interaction effects of nitrogen and phosphorus for number of pods per plant and pod yield was significant at $N_{150}$ $P_{80}$ levels where as it was non significant with regards to pod weight and length. The pod quality characters like crude fibre and crude protein showed increasing trend with increased level of nitrogen upto 100 kg ha$^{-1}$ and phosphorus upto 80 kg ha$^{-1}$. Interaction effect of N and P was significant at $N_{150}$ $P_{80}$ level for protein content but was nonsignificant with regards to crude fibre content. Therefore nitrogen at 100 kg ha$^{-1}$ and phosphorus at 80 kg ha$^{-1}$ is recommended for obtaining optimum pod yield and quality in french bean.

French bean (*Phaseolus vulgaris* L.) is an important legume vegetable cultivated throughout India. It is grown both as a green vegetable and as a pulse crop (Rajmah). Though french bean is a leguminous crop it is a shy nodulator and requires fairly large quantities of nitrogenous fertilizers (Hegde and Srinivas, 1989). However, the efficacy of nitrogen fixation varies in relation to the availability of different levels of nitrogen and phosphorus.

Application of nitrogenous fertilizers was reported to increase the number of pods per plant and seeds per pod in pulses to a considerable extent (Saxena and Verma, 1995). Phosphorus plays an important role in cell division and harvesting maturity of the plants. Phosphorus has vital role in root development and nodulation as well (Rana and Singh, 1998).

The low productivity of french bean has been attributed mainly to inadequate fertilization. The nitrogenous and phosphatic fertilizers are often applied to the soil together and hence a careful consideration in order to determine their ultimate benefits to the plant is of considerable importance. A definite balance between nitrogen and phosphorus supply in this soil appears to be necessary for ensuring a successful crop production.

Keeping in view of the above, an experiment was conducted to study the effect of nitrogen and phosphorus on growth, yield and quality of french bean.

## MATERIAL AND METHODS

A field study was carried out during *rabi* 1998 at Horticultural Garden, S.V. Agricultural College, Tirupati in a sandy loam soil with pH 7.4 containing 228 kg ha$^{-1}$ of available nitrogen, 35 kg ha$^{-1}$ of available phosphorus and 190 kg ha$^{-1}$ of available potassium.

Seeds of french bean cv. Arka Komal were sown on 20th November 1998. The inter and intra row spacing was maintained at 50 cm and 15 cm respectively. The treatments comprised of four nitrogen levels (0,50,100, and 150 kg ha$^{-1}$) and three phosphorus levels (0,40 and 80 kg ha$^{-1}$). The trial was carried out in a factorial RBD with twelve treatments replicated thrice. A uniform basal dose of 40 kg $K_2O$ ha$^{-1}$ was applied at the time of sowing. Total phosphorus as per treatments was applied as a basal dose at the time of sowing. Nitrogen was applied in two equal splits i.e. one at the time of sowing and the remaining one month after sowing. For convenience the data on growth parameters were presented at 60 days after sowing only.

## RESULTS AND DISCUSSION

Application of nitrogen significantly increased all the growth parameters (Table 1) like plant height, leaf area per plant, leaf area index and dry matter production. This increase in growth may be due to increase in size of cells, meristematic activities and formation and function of protoplasm which consequently increase the crop growth (Verma and Saxena, 1995, Rana and Singh, 1998, Rana *et al.*, 1998).

Plant height, leaf area, leaf area index and dry matter (Table 1) increased significantly with increase in phosphorus application upto 80 kg ha$^{-1}$. This significant increase in growth attributes due to phosphorus application may be because of proliferation of root system which results in better absorption of nutrients and there by better growth (Ssaili and Keya, 1975; Bonetti *et al.*, 1984; Rana and Singh, 1998).

Significant increase in plant height, leaf area, leaf area index and dry matter production due to interaction of nitrogen and phosphorus was recorded at $N_{150}$ $P_{80}$ level at all stages of crop growth.

Application of nitrogen had significant positive influence on yield attributing characters like number of pods per plant, pod length, pod weight and pod yield (Table 2). This significant influence may be because the nitrogen is an essential constituent of chlorophyll, protoplasm and enzyme which governs the utilization of phosphorus and potash and its ample availability might have resulted in significant increase in yield attributes (Pande *et al.*, 1974).

Phosphorus at 80 kg ha$^{-1}$ significantly increased the yield parameters (Table 2) than other phosphorus levels. This may be due to the fact that all metabolic processes like photosynthesis and respiration are depending upon the action of co-enzymes like NAD, NADP which are phosphorus dependents (Naik, 1992).

The interaction effect due to nitrogen and phosphorus at $N_{150}$ $P_{80}$ level was significant on number of pods per plant where as non significant

Table 1 : Effect of nitrogen and phosphorus on growth attributes of french bean at 60 days after sowing.

| Treatment | Plant height (cm) | | | | Leaf area / plant (cm$^2$) | | | | Leaf area index | | | | Dry matter (g/plant) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $P_0$ | $P_{40}$ | $P_{80}$ | Mean | $P_0$ | $P_{40}$ | $P_{80}$ | Mean | $P_0$ | $P_{40}$ | $P_{80}$ | Mean | $P_0$ | $P_{40}$ | $P_{80}$ | Mean |
| $N_0$ | 30.3 | 36.9 | 39.2 | 35.5 | 603.0 | 696.7 | 758.2 | 685.9 | 0.8 | 0.9 | 1.0 | 0.9 | 19.3 | 19.5 | 19.5 | 19.4 |
| $N_{50}$ | 36.6 | 39.7 | 42.1 | 39.5 | 730.5 | 781.5 | 834.0 | 782.0 | 1.0 | 1.0 | 1.1 | 1.0 | 19.4 | 19.7 | 19.7 | 19.6 |
| $N_{100}$ | 39.1 | 42.7 | 45.6 | 42.5 | 792.7 | 861.7 | 924.0 | 859.4 | 1.1 | 1.2 | 1.2 | 1.1 | 19.6 | 20.0 | 20.0 | 19.9 |
| $N_{150}$ | 42.2 | 45.2 | 48.5 | 45.3 | 887.2 | 959.2 | 1022.2 | 956.2 | 1.2 | 1.3 | 1.4 | 1.3 | 20.0 | 20.3 | 20.3 | 20.1 |
| Mean | 37.1 | 41.1 | 43.8 | | 753.3 | 824.7 | 884.6 | | 1.0 | 1.1 | 1.2 | | 19.6 | 19.9 | 19.9 | |
| | N | P | N x P | | N | P | N x P | | N | P | N x P | | N | P | N x P | |
| CD at 5% | 0.10 | 0.08 | 0.17 | | 4.07 | 3.52 | 7.05 | | 0.01 | 0.01 | 0.01 | | 0.07 | 0.06 | NS | |

NS - Non significant

Table 2 : Effect of nitrogen and phosphorus on yield attributes and yield of french bean.

| Treatment | No. of pods / plant | | | | Pod weight (g/plant) | | | | Pod length (cm) | | | | Pod yield (kg/ha) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $P_0$ | $P_{40}$ | $P_{80}$ | Mean | $P_0$ | $P_{40}$ | $P_{80}$ | Mean | $P_0$ | $P_{40}$ | $P_{80}$ | Mean | $P_0$ | $P_{40}$ | $P_{80}$ | Mean |
| $N_0$ | 9.0 | 12.9 | 13.8 | 11.9 | 43.2 | 63.1 | 67.4 | 57.9 | 12.6 | 14.1 | 14.9 | 13.9 | 5086.6 | 9670.0 | 10333.3 | 8363.3 |
| $N_{50}$ | 12.3 | 15.5 | 16.2 | 14.7 | 60.4 | 77.6 | 84.2 | 74.0 | 14.4 | 15.3 | 16.3 | 15.4 | 9246.6 | 12233.3 | 14566.6 | 12015.5 |
| $N_{100}$ | 13.1 | 16.0 | 16.9 | 15.3 | 66.9 | 83.3 | 91.0 | 80.4 | 16.0 | 16.9 | 17.5 | 16.8 | 12950.0 | 14426.6 | 15700.0 | 14358.8 |
| $N_{150}$ | 13.4 | 16.6 | 16.9 | 15.6 | 71.0 | 91.0 | 94.5 | 85.5 | 16.8 | 17.4 | 18.3 | 17.5 | 13110.0 | 14450.0 | 15925.0 | 14495.0 |
| Mean | 12.0 | 15.3 | 15.9 | | 60.3 | 78.7 | 84.2 | | 15.0 | 15.9 | 16.7 | | 10098.3 | 12694.9 | 14131.0 | |
| | N | P | N x P | | N | P | N x P | | N | P | N x P | | N | P | N x P | |
| CD at 5% | 0.91 | 0.79 | 1.57 | | 16.5 | NS | NS | | 0.09 | 0.08 | NS | | 147.4 | 127.6 | 255.2 | |

NS - Non significant

Table 3 : Effect of nitrogen and phosphorus on quality of french bean.

| Treatment | Crude fibre | | | | Crude protein | | | |
|---|---|---|---|---|---|---|---|---|
| | $P_0$ | $P_{40}$ | $P_{80}$ | Mean | $P_0$ | $P_{40}$ | $P_{80}$ | Mean |
| $N_0$ | 1.55 | 2.00 | 2.03 | 1.86 | 1.93 | 2.75 | 2.87 | 2.51 |
| $N_{50}$ | 1.75 | 2.09 | 2.10 | 1.98 | 3.06 | 3.18 | 3.43 | 3.22 |
| $N_{100}$ | 1.80 | 2.14 | 2.17 | 2.03 | 3.31 | 3.37 | 3.56 | 3.41 |
| $N_{150}$ | 1.90 | 2.22 | 2.22 | 2.11 | 3.50 | 3.62 | 3.68 | 3.60 |
| Mean | 1.73 | 2.11 | 2.13 | | 2.95 | 3.23 | 3.38 | |
| | N | P | N x P | | N | P | N x P | |
| CD at 5% | 0.062 | 0.053 | NS | | 0.081 | 0.070 | 0.141 | |

NS - Non significant

with regards to pod weight and pod length.

Nitrogen and phosphorus fertilization had positive response on pod yield (Table 2). Application of nitrogen upto 100 kg ha$^{-1}$ increased the pod yield over no nitrogen application. Application over and above 100 kg N ha$^{-1}$ i.e. 150 kg N ha$^{-1}$ did not result in significant yield increase and these results are coinciding with the findings of Srinivas and Prabhakar 1985. Increase in application of phosphorus upto 80 kg ha$^{-1}$ increased the pod yield (Table 2) significantly compared to other doses (Paneer Selvam, 1980).

The above increase in pod yield due to application of nitrogen and phosphorus may be due to the fact that different growth and yield contributing characters like pod length, pod growth, number of pods per plant increased consequently leading to more green pod yield.

Interaction effect of nitrogen and phosphorus was significant on pod yield at $N_{150}$ $P_{80}$ level (Table 2).

The yield increase at 100 kg N ha$^{-1}$ was 71.7 per cent over control. Similarly, the increase in yield at 80 kg $P_2O_5$ ha$^{-1}$ was 39.9 per cent over control. The increase in yield at $N_{150}$ $P_{80}$ level was 208.7 per cent over N0P0 level. There was no significant difference between yield at $N_{100}$ $P_{80}$ level an $N_{150}$ $P_{80}$ level.

The pod quality characters (Table 3) like crude fire and crude protein contents increased significantly with the increase in application of nitrogen (upto 150 kg ha$^{-1}$). The significant increase in the above pod quality characters may be due to favourable effect of nitrogen on crop growth which in turn increased the protein production. This may also be due to enhanced utilization of nitrogen by phosphorus application which in turn enhances the protein synthesis in plant and ultimately improved the quality of the produce by increasing the protein bodies (Bagal and Jadhav, 1995; Pradhan *et al.*1995 and Verma and Saxena, 1995).

Interaction of N and P was not significant in case of crude fibre where as it was signficant in case of crude protein content and the highest protein content was observed with $N_{150}$ and $P_{80}$ levels.

It was concluded that nitrogen and phosphorus at the rate of 100 kg and 80 kg ha$^{-1}$ respectively improved the growth, yield and quality of french bean.

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(Received on 16-09-2000 and revised on 24-12-2003)

*The Andhra Agric.* J. **50** (3&4) : 263 - 268, 2003

# Effect of Sulphur Application and *Rhizobium* Inoculation to Greengram on Soil Urease and Dehydrogenase activity

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## ABSTRACT

Field experiments were conducted to study the effect of sulphur application and *Rhizobium* inoculation to greengram on soil urease and dehydrogenase activity. The results revealed that an application of different doses of sulphur (0,20,40 and 60 Kg ha$^{-1}$) decreased the urease and dehydrogenase activities in rhizosphere soils of greengram. *Rhizobium* inoculation with USDA - 3463 or $M_4$ significantly increased the activities of urease and dehydrogenase over uninoculated control. The activities of the enzymes increased progressively from 15 DAS to 45 DAS and later on decreased.

**Key words :** Sulphur, *Rhizobium* inoculation, Soil Urease, Dehydrogenase activity.

Soil enzymes play a vital role in the release of nutrients by mineralization. The balance between microbes and enzymes activities viz., urease and dehydrogenase in soil is very important for nutrient release (Nagaraja *et al.,* 1998). Farmers apply sulphur to alleviate sulphur deficiency and to get higher yields. But there is scanty information on the influence of sulphur on soil biological activity mediated by soil enzymes. Therefore, the present investigation was undertaken to study the effect of sulphur application and *Rhizobium* inoculation and their interaction on urease and dehydrogenase activities in the rhizosphere soils of greengram.

## MATERIAL AND METHODS

Field experiments were conducted in *Kharif,* 1991 and 1992 on sandy loam (Udic Ustochrepts) soil with greengram as a test crop with four levels of Sulphur (0, 20 , 40 and 60 Kg ha$^{-1}$ as elemental Sulphur) and two strains of *Rhizobium leguminosarum* biovar Phaseoli (USDA-3463 and $M_4$) in factorial randomized design. The experimental soil has a pH (1:2.5 of 7.5, available N 325 Kg ha$^{-1}$, available P 11 Kg ha$^{-1}$, available K 325 Kg ha$^{-1}$ and available Sulphate sulphur (extracted with $NH_4OAc+CH_3COOH$).

Urease activity was estimated by the method of (Tabatabai, 1982). Dehydrogenase activity was estimated by TTC reduction (Casida *et al.,* 1964). The rhizosphere microflora (Total bacteria, fungi and actinomycetes) were estimated by plate count method on Asparagine Mannitol agar medium, Rose-bengal agar medium and Kenknight Munaier's medium respectively. Multiple regression analysis was carried out by taking urease and dehydrogenase activities as dependent variables (Y) and bacteria ($X_1$), fungi($X_2$) and actinomycetes (x3) as independent variables.

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Table 1 : Periodical changes in urease activity (µg TPF g$^{-1}$ soil d$^{-1}$) in soil as influenced by sulphur application and *Rhizobium* inoculation

| Treatment | *Kharif* 1991 | | | | *Kharif* 1992 | | | |
|---|---|---|---|---|---|---|---|---|
| | Days after sowing | | | | Days after sowing | | | |
| | 15 | 30 | 45 | 60 | 15 | 30 | 45 | 60 |
| Sulphur levels | | | | | | | | |
| $S_0$ | 196.43 | 202.76 | 277.60 | 224.37 | 160.26 | 196.66 | 242.61 | 214.00 |
| $S_{20}$ | 177.88 | 184.92 | 246.49 | 212.37 | 163.19 | 164.44 | 229.87 | 197.86 |
| $S_{40}$ | 149.57 | 141.51 | 243.81 | 184.10 | 143.13 | 139.06 | 216.72 | 178.41 |
| $S_{60}$ | 74.17 | 77.71 | 226.60 | 164.13 | 163.97 | 73.38 | 204.97 | 134.00 |
| LSD (P = 0.05) | 4.73 | 4.09 | 4.52 | 4.12 | 7.62 | 3.32 | 3.86 | 4.49 |
| *Rhizobium* inoculation | | | | | | | | |
| $Rh_0$ (uninoculated) | 137.38 | 143.48 | 228.04 | 191.78 | 119.32 | 133.66 | 202.72 | 175.53 |
| $M_4$ | 155.75 | 161.74 | 250.82 | 195.09 | 137.87 | 152.16 | 211.91 | 182.05 |
| USDA - 3463 | 155.29 | 149.54 | 267.02 | 201.10 | 140.71 | 144.33 | 255.99 | 185.62 |
| LSD (P = 0.05) | 4.09 | 3.55 | 3.91 | 3.36 | 6.60 | 2.87 | 3.35 | 3.89 |
| Sulphur x *Rhizobium* inoculation | | | | | | | | |
| $S_0$ x $Rh_0$ | 141.60 | 195.10 | 248.70 | 221.60 | 130.42 | 190.82 | 220.30 | 210.70 |
| $S_0$ x $M_4$ | 170.50 | 230.50 | 275.90 | 204.50 | 158.20 | 210.53 | 232.60 | 201.17 |
| $S_0$ x USDA-3463 | 221.50 | 182.20 | 308.20 | 247.00 | 192.15 | 188.62 | 274.92 | 230.13 |
| $S_{20}$ x $Rh_0$ | 187.13 | 154.20 | 258.90 | 196.00 | 138.09 | 143.50 | 218.40 | 190.00 |
| $S_{20}$ x $M_4$ | 221.50 | 175.40 | 267.40 | 192.00 | 181.33 | 103.50 | 210.70 | 198.60 |
| $S_{20}$ x USDA-3463 | 180.67 | 225.17 | 213.17 | 248.70 | 170.14 | 186.31 | 260.50 | 204.97 |
| $S_{40}$ x $Rh_0$ | 130.20 | 132.33 | 230.00 | 170.50 | 128.42 | 120.18 | 200.20 | 160.53 |
| $S_{40}$ x $M_4$ | 145.50 | 150.20 | 218.07 | 204.50 | 140.64 | 142.66 | 204.23 | 184.30 |
| $S_{40}$ x USDA-3463 | 173.00 | 142.00 | 283.37 | 177.30 | 160.32 | 154.34 | 245.73 | 194.50 |
| $S_{60}$ x $Rh_0$ | 90.60 | 92.39 | 174.57 | 179.00 | 80.36 | 80.13 | 171.99 | 140.90 |
| $S_{60}$ x $M_4$ | 85.50 | 90.87 | 241.90 | 182.50 | 71.31 | 91.95 | 200.10 | 144.13 |
| $S_{60}$ x USDA-3463 | 46.00 | 48.33 | 263.33 | 131.40 | 40.24 | 48.06 | 242.81 | 116.97 |
| LSD (P =0.005) | 8.19 | 7.09 | 7.83 | 7.13 | 13.20 | 5.07 | 6.69 | 7.78 |

## RESULTS AND DISCUSSION

### Urease and Dehydrogenase activities

Sulphur application from 0 to 60 Kg ha$^{-1}$ decreased the activities of urease and dehydrogenase in rhizosphere of greengram at all stages of crop growth during both the year (Tables 1 & 2). Bitton and Boylan (1985) reported that a reduction in dehydrogenase and urease activities due to acid rains. Gupta *et al.*

Table 2 : Periodical changes in dehydrogenase activity (µg urea hydrolysed $g^{-1}$ soil $h^{-1}$) in soil as influenced by sulphur application and *Rhizobium* inoculation

| Treatment | *Kharif* 1991 | | | | *Kharif* 1992 | | | |
|---|---|---|---|---|---|---|---|---|
| | Days after sowing | | | | Days after sowing | | | |
| | 15 | 30 | 45 | 60 | 15 | 30 | 45 | 60 |
| Sulphur levels | | | | | | | | |
| $S_0$ | 6.02 | 7.36 | 13.59 | 5.80 | 5.18 | 6.89 | 11.88 | 5.17 |
| $S_{20}$ | 5.54 | 5.91 | 1179 | 5.42 | 4.71 | 6.09 | 11.08 | 4.40 |
| $S_{40}$ | 4.80 | 5.13 | 7.46 | 4.14 | 4.32 | 4.81 | 6.69 | 3.79 |
| $S_{60}$ | 4.02 | 4.66 | 6.05 | 3.84 | 3.71 | 4.27 | 5.27 | 8.37 |
| LSD (P = 0.05) | 0.96 | 1.01 | 0.97 | 0.87 | 0.64 | 0.66 | 1.17 | 0.74 |
| *Rhizobium* inoculation | | | | | | | | |
| $Rh_0$ (uninoculated) | 4.93 | 5.98 | 7.92 | 4.57 | 4.18 | 5.08 | 6.75 | 3.69 |
| $M_4$ | 4.87 | 6.00 | 9.52 | 4.71 | 4.42 | 5.55 | 8.27 | 4.13 |
| USDA - 3463 | 5.49 | 6.07 | 11.70 | 5.13 | 4.82 | 5.92 | 11.17 | 4.71 |
| LSD (P = 0.05) | NS | NS | 0.84 | NS | NS | 0.57 | 1.01 | 0.64 |
| Sulphur x *Rhizobium* inoculation | | | | | | | | |
| $S_0$ x $Rh_0$ | 5.87 | 7.20 | 10.60 | 5.13 | 4.73 | 6.10 | 9.30 | 4.73 |
| $S_0$ x $M_4$ | 5.80 | 7.47 | 12.80 | 5.87 | 5.10 | 7.24 | 11.20 | 5.10 |
| $S_0$ x USDA-3463 | 6.40 | 7.40 | 17.38 | 6.40 | 5.70 | 7.33 | 15.13 | 5.70 |
| $S_{20}$ x $Rh_0$ | 5.33 | 7.20 | 9.33 | 4.80 | 4.30 | 6.07 | 8.21 | 4.10 |
| $S_{20}$ x $M_4$ | 5.41 | 6.67 | 12.10 | 5.33 | 4.76 | 5.90 | 10.40 | 3.90 |
| $S_{20}$ x USDA-3463 | 5.87 | 6.87 | 13.94 | 6.13 | 5.07 | 6.30 | 14.62 | 5.20 |
| $S_{40}$ x $Rh_0$ | 5.06 | 4.53 | 6.40 | 4.00 | 4.27 | 4.20 | 5.10 | 3.00 |
| $S_{40}$ x $M_4$ | 4.53 | 5.60 | 7.45 | 3.90 | 4.00 | 4.90 | 6.47 | 3.83 |
| $S_{40}$ x USDA-3463 | 4.80 | 5.27 | 8.53 | 4.53 | 4.70 | 5.33 | 8.50 | 4.53 |
| $S_{60}$ x $Rh_0$ | 3.47 | 5.00 | 5.33 | 4.33 | 3.40 | 3.95 | 4.40 | 2.92 |
| $S_{60}$ x $M_4$ | 3.73 | 4.27 | 5.90 | 3.73 | 3.80 | 4.17 | 5.00 | 3.70 |
| $S_{60}$ x USDA-3463 | 4.87 | 4.72 | 6.93 | 3.47 | 3.93 | 4.70 | 6.42 | 3.40 |
| LSD (P =0.005) | NS | NS | 1.67 | NS | NS | NS | NS | NS |

(1998) also reported that an application of elemental sulphur (50 Kg $ha^{-1}$) has significantly reduced the urease and dehydrogenase activities in the soil.

Inoculation with either USDA-3463 or $M_4$ strains of *Rhizobium* increased the urease and dehydrogenase activities over uninoculated control (Tables 1 & 2). This may be due to

Table 3 : Multiple regression equations and correlation coefficients between urease activity (Y) and population of bacteria ($X_1$), fungi ($X_2$) and actinomycetes ($X_3$) at different stages of crop growth.

Multiple Linear Regression Equations

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | *Kharif* 1991 | | | | | |
| Y at 15 DAS | = | 21.90 | - | 0.088 $X_1$ | + | 10.13 $X_2$ | + | 11.76 $X_3$ | ($R^2$ = 0.521) |
| Y at 30 DAS | = | -11.67 | - | 2.11 $X_1$ | + | 10.93 $X_2$ | - | 0.771 $X_3$ | ($R^2$ = 0.722**) |
| Y at 45 DAS | = | 84.68 | - | 0.476 $X_1$ | + | 1.63 $X_2$ | - | 8.31 $X_3$ | ($R^2$ = 0.457) |
| Y at 60 DAS | = | 182.35 | - | 3.56 $X_1$ | + | 9.41 $X_2$ | + | 0.995 $X_3$ | ($R^2$ = 0.577) |
| | | | | *Kharif* 1992 | | | | | |
| Y at 15 DAS | = | - 43.29 | + | 2.08 $X_1$ | + | 0.713 $X_2$ | + | 1.269* $X_3$ | ($R^2$ = 0.760**) |
| Y at 30 DAS | = | - 162.15 | - | 3.08 $X_1$ | - | 0.800 $X_2$ | + | 1.092 $X_3$ | ($R^2$ = 0.671*) |
| Y at 45 DAS | = | -186.22 | + | 6.10* $X_1$ | - | 0.055 $X_2$ | + | 0.273 * $X_3$ | ($R^2$ = 0.753**) |
| Y at 60 DAS | = | - 72.25 | - | 0.757 $X_1$ | + | - 1.05 $X_2$ | + | 0.370 $X_3$ | ($R^2$ = 0.591) |

Correlation Coefficients ('r' values)

| Urease activity | Bacteria | | Fungi | | Actinomycetes | |
|---|---|---|---|---|---|---|
| | 1991 | 1992 | 1991 | 1992 | 1991 | 1992 |
| 15 DAS | 0.011 | 0.124 | 0.620** | 0.589 | 0.660* | 0.541 |
| 30 DAS | -0.236 | -0.207 | 0.840** | 0.849** | 0.829** | 0.864** |
| 45 DAS | -0.474 | -0.084 | 0.549 | 0.486 | 0.672* | 0.656** |
| 60 DAS | -0.671* | -0.666* | 0.714** | 0.834** | 0.676* | 0.755** |

* Significant at 5% level

** Singnificant at 1% level

stimulation of plant roots and rhizosphere microorganisms by *Rhizobium* (Pal and Chhonkar, 1981).

The interaction between sulphur and *Rhizobium* inoculation showed positive influence on the activities of urease and dehydrogenase (Table 1 & 2). However the interaction effect in statistically significant in case of urease and non-significant in case of dehydrogenase. Combined use of sulphur and *Rhizobium* inoculation might have promoted extensive root growth, might have which may enhanced the population of ureolytic bacteria leading to production of more urease.

Soil enzymes activity was not static but dynamic in nature and changed with crop growth. Urease and dehydrogenase activities were increased from 15 DAS to 45 DAS and later on decreased (Tables 1 & 2). The increased activities of these enzymes with the age of crop might be due to the gradual build up of the microorganisms in the soil. Increase in dehydrogenase activity with increase in plant growth and further decline at the time of harvest was also reported by Lalita Batra (1998). Similar findings were also reported by Rao *et al.* (1990).

## Relationship between urease activity and microbial population

Multiple regression equations explain that the microbial population put together brought about 52.1, 72.2, 45.7 and 57.7 percent in first year and 48.1, 77.4, 68.4 and 75.8 percent

Table 4 : Multiple linear regression equations and correlation coefficients between dehydrogenase activity (Y) and population of bacteria ($X_1$), fungi ($X_2$) and actinomycetes ($X_3$) at different stages of crop growth.

Multiple Linear Regression Equations

*Kharif* 1991

$Y$ at 15 DAS $= 67.53 - 0.572\ X_1 + 6.66\ X_2 + 1.01^{*}\ X_3$ $(R^2 = 0.714^{**})$
$Y$ at 30 DAS $= 2.60 - 0.0069\ X_1 + 0.342\ X_2 - 0.038^{*}\ X_3$ $(R^2 = 0.845^{**})$
$Y$ at 45 DAS $= 3.35 - 0.064\ X_1 + 0.252^{*}\ X_2 - 0.005\ X_3$ $(R^2 = 0.816^{**})$
$Y$ at 60 DAS $= 2.06 - 0.060\ X_1 + 0.013\ X_2 + 0.328\ X_3$ $(R^2 = 0.722^{*})$

*Kharif* 1992

$Y$ at 15 DAS $= -7.65 + 0.119\ X_1 + 0.713\ X_2 + 1.269^{*}\ X_3$ $(R^2 = 0.760^{**})$
$Y$ at 30 DAS $= -7.20 - 0.033\ X_1 - 0.800\ X_2 + 1.092\ X_3$ $(R^2 = 0.671^{*})$
$Y$ at 45 DAS $= -2.40 + 0.050\ X_1 - 0.055\ X_2 + 0.273^{*}\ X_3$ $(R^2 = 0.754^{*})$
$Y$ at 60 DAS $= -0.187 - 0.134\ X_1 - 1.05\ X_2 + 0.370\ X_3$ $(R^2 = 0.591)$

Correlation Coefficients ('r' values)

| Dehydrogenase activity | Bacteria | | Fungi | | Actinomycetes | |
|---|---|---|---|---|---|---|
| | 1991 | 1992 | 1991 | 1992 | 1991 | 1992 |
| 15 DAS | -0.027 | -0.033 | 0.711** | 0.558 | 0.814** | 0.819** |
| 30 DAS | -0.262 | -0.165 | 0.907** | 0.693* | 0.888** | 0.745** |
| 45 DAS | -0.609* | -0.397 | 0.869** | 0.712** | 0.822** | 0.849** |
| 60 DAS | -0.699* | -0.628* | 0.739** | 0.712** | 0.840** | 0.697* |

* Significant at 5% level
** Singnificant at 1% level

variability in urease activity in second year at 15,30,45 and 60 DAS (Table 3). However, the coefficients in regression equations in second year suggest that the bacteria, fungi and actinomycetes populations were important and significant in predicting variability in urease activity.

The correlation coefficient (r) calculated showed that the urease activity was negatively and significantly correlated with bacteria at 60 DAS during both the years of study (Table 3). Further, the urease activity was positively and significantly correlated with fungal population at 15, 30 and 60 DAS during both years except at 15 DAS in second year. The correlations worked out between urease activity and actinomycetes population was positive and significant at all stages during both the years except and 15 DAS in second year.

## Relationship between dehydrogenase activity and microbial population

The estimated multiple regression equations revealed that the microbial population put together brought about 71.4, 84.5, 81.6 and 72.2 percent in first year and 76.0, 67.1, 75.30 and 59.1 per cent variability in dehydrogenase activity in second year at 15,30,45 and 60 DAS (Table 4). However, the coefficients in regression equations suggested that the fungi and actinomycetes populations in first year and actinomycetes in second year were dominant in predicting variability in dehydrogenase.

The correlations worked out between dehydrogenase activity and bacteria was negatively and significantly correlated at 45 and 60 DAS in first year (Table 4). Further, the dehydrogenase activity was positively and significantly correlated with fungi and actinomycetes population at all stages during both years except in case of fungi at 15 DAS in second year.

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(Received on 05-03-2002 and revised on 08-07-2003)

*The Andhra Agric.* J. **50** (3&4) : 269 - 275, 2003

# Development of Life Tables of The Cabbage Leaf Webber, *Crocidolomia binotalis* Zell. infesting Mustard

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## ABSTRACT

A field and laboratory study was conducted at Agricultural College, Bapatla for the development of life table of *Crocidolomia binotalis* Zell. on mustard during *rabi* 2000 - 2001. The age specific life table revealed that the period-I larvae are more vulnerable to natural mortality factors, during both the first and the second generations. The highest survival rate ($S_x$) was observed in pupal stage which was 0.76 and 0.73 in the first and the second generations, respectively. The trend index was 18.36 in the first generation and 18.88 in the second generation. The generation survival was high (0.18) in the first generation when compared to the second generation (0.16). The age specific fecundity table revealed that the intrinsic rate of increase ($r_m$) was high in the first generation which was 0.0688 as against 0.0609 in the second generation. The net reproductive rate ($r_0$) was 9.6631 and 7.5896 in the first and the second generations, respectively. The population doubled in 10.07 days in the first generation where as it was 11.38 days in the second generation.

**Key words :** Cabbage leaf Webber, Life table, mustard, Trend index, Net reproductive rate.

Mustard is the second important oil seed crop after groundnut which is mostly grown in temperate and warm temperate regions of Asia and Europe. In India it occupies an area of 6.47 m.ha with a production of 5.88 m.t. (Directorate of Economics and Statistics, 1995). In Andhra Pradesh, it is grown in 4818 ha with a production of 1415 t (A.P. Statistical Abstract, 1993). The production potential of mustard is often hampered by various pest problems and about 24 insect pests have been reported on mustard at different stages of crop growth (Rai, 1976). Among different pests, the cabbage leaf webber, *Crocidolomia binotalis* Zell. is one of the most important pests on mustard. Life table concept provides keys to the practical understanding of the pest problems in Agro-Ecosystem useful for practical manipulation of control factors in crop habitats. Pest life tables provide information on the stages of the life cycle that contribute most to the population and key mortality factors due to biotic and abiotic stresses (NAS 1969). The information is critical for planning the most effective insecticidal interventions, their timing and integration with key factors. Hence the present study was aimed to develop life tables of *Crocidolomia binotalis* Zell. on mustard.

## MATERIAL AND METHODS

A field and laboratory investigation was conducted at Bapatla for the construction of life table of *Crocidolomia binotalis* Zell. on mustard. A bulk plot of 200 sq.m was raised at Agricultural college farm, Bapatla, during *rabi* 2000 - 2001. The test variety used was Seeta. All the usual agronomic practices were carried out as for the recommendations. In the bulk plot, sample units of 1 sq.m were marked with pegs at 10 randomly selected places, for recording the absolute population of the pests. For the sampling purpose, the entire larval period was divided into three phases. The first and second instars were

Table 1 : Age specific life table of *C.binotalis* for the first generation on mustard during rabi 2000- 2001

| Stage of insect (x) | Number living at the beginning ($l_x$) | Factor responsible for dx (dfx) | Number dying during x (dx) | dx as a per cent of $l_x$ (100 qx) | Survival rate with in x ($S_x$) | Log $l_x$ | K-value |
|---|---|---|---|---|---|---|---|
| Expected eggs | 113 | Sterility | 13 | 11.2 | | 2.0492 | |
| Viable eggs | 100 | | | | 0.88 | 2.0000 | 0.0492 |
| Period I Larvae ($N_1$) | 100 | Parasitoids | 24 | 24.00 | | 2.0000 | 0.1192 $k_1$ |
| | 76 | Predators | 2 | 2.00 | | 1.8808 | 0.0116$k_2$ |
| | 74 | Unknown | 18 | 18.00 | | 1.8692 | 0.1211$k_3$ |
| | 56 | Subtotal | 44 | 44.00 | 0.56 | 1.7481 | 0.2519 |
| Period II Larvae | 56 | Parasitoids | 8 | 14.28 | | 1.7481 | 0.0669 $k_4$ |
| | 48 | Predators | 2 | 3.57 | | 1.6812 | 0.0185$k_5$ |
| | 46 | Unknown | 7 | 12.50 | | 1.6627 | 0.0717$k_6$ |
| | 39 | Subtotal | 17 | 30.35 | 0.69 | 1.5910 | 0.1571 |
| Period III Larvae | 39 | Parasitoids | 6 | 15.38 | | 1.5910 | 0.0725$k_7$ |
| | 33 | Predators | 1 | 2.56 | | 1.5185 | 0.0134$k_8$ |
| | 32 | Unknown | 7 | 17.94 | | 1.5051 | 0.1072$k_9$ |
| | 25 | Subtotal | 14 | 35.88 | 0.64 | 1.3979 | 0.1931 |
| Pupa | 25 | Parasitoids | 1 | 4.00 | | 1.3979 | 0.0177$k_{10}$ |
| | 24 | Fail to emerge | 5 | 20.00 | | 1.3802 | 0.1015$k_{11}$ |
| | 19 | Subtotal | 6 | 24.00 | 0.76 | 1.2787 | 0.1192 |
| Adults | 19 | | | | | | K = 0.7705 |

Sex Ratio (male : female) = 1.09 : 1.0

Average fecundity = 204 eggs/ female

Number of females x average fecundity ($N_2$) = 1836

Female x 2 ($N_3$) = 18

Trend index (I) $N_2/N_1$ = 18.36

Generation survival (SG) $N_3/N_1$ = 0.18

considered as period - I larvae, third and fourth instars as period-II larvae and fifth instar as period-III larvae. The observations on life table were started with an initial cohort of 100 first instar larvae. Population of the cabbage leaf webber was regularly monitored and observations were taken from the time of pest appearance and continued for two successive generations. The census on live and dead larvae were recorded regularly in each phase upto pupation. Simultaneously, a batch of 100 larvae were collected at each count from other than the sample units and reared in the laboratory to observe the extent of parasitism, disease manifestation or other mortality factors. After pupation the pupae were allowed in the field for

Table 2 : Age specific fecundity table of C. *binotalis* for first generation :

| Pivotal age in days (x) | $l_x$ | $m_x$ | $l_x m_x$ | $x.l_x m_x$ | Trial $r_m$ | | Accurate $r_m$ |
|---|---|---|---|---|---|---|---|
| | | | | | 0.06 | 0.07 | 0.0688 |
| | | | | | $e^{7-rmx}.l_x m_x$ | $e^{7-rmx}.l_x m_x$ | $e^{7-rmx}.l_x m_x$ |
| 29 | 0.091 | | | | | | |
| 30 | 0.091 | 5.7370 | 0.5220 | 15.66 | 94.62 | 70.09 | 72.67 |
| 31 | 0.091 | 14.6785 | 1.3357 | 41.40 | 228.02 | 167.24 | 173.59 |
| 32 | 0.091 | 18.6070 | 1.6932 | 54.18 | 272.22 | 197.67 | 205.41 |
| 33 | 0.091 | 26.4640 | 2.4082 | 79.47 | 364.62 | 262.14 | 273.73 |
| 34 | 0.080 | 20.2850 | 1.6228 | 55.17 | 231.40 | 164.70 | 171.57 |
| 35 | 0.070 | 19.1070 | 1.3374 | 46.81 | 179.59 | 126.56 | 132.00 |
| 36 | 0.040 | 13.6785 | 0.5471 | 19.69 | 69.19 | 48.27 | 50.40 |
| 37 | 0.020 | 9.8350 | 0.1967 | 7.27 | 23.42 | 16.18 | 16.90 |
| 38 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | | 128.39 | 9.6631 | 319.65 | 1463.08 | 1052.85 | 1096.27 |

Net reproductive rate ($r_0$) = 9.6631

Mean duration of generation ($T_c$) = 33.09 days

Capacity for increase ($r_c$) = 0.0685

Intrinsic rate of increase ($r_m$) = 0.0688

Finite rate of increase ($\lambda$) = 1.0712

Weekly multiplication rate ($\lambda^7$) = 1.5316

Corrected generation Time (T) = 32.28 days

Doubling time (DT) = 10.07 days

three to four days to expose them to natural mortality factors and then the pupae were brought to the laboratory and observed further till the adult emergence. If the adults did not emerge the reason for the failure was recorded. With the available data the age specific life tables were constructed according to the format given by Atwal and Bains (1974).

The adults emerged from the field collected pupae were utilized for the construction of age specific fecundity table in the laboratory. After the emergence of adults they were sexed based on abdominal and wing characters. A pair of adults was enclosed in oviposition jars and allowed for oviposition. Each jar was covered with muslin cloth and provided with fresh mustard leaves and cotton swab dipped in 10 per cent honey to serve as adult food and they were changed daily at the time of egg counting. The number of surviving females and number of eggs laid by each female were recorded daily till the death of the female. Per cent egg mortality was also recorded in the laboratory. The data thus obtained were used for the construction of age specific fecundity table according to the format suggested by Birch (1948).

The net reproductive rate ($r_0 = \Sigma\ l_x.m_x$), approximate generation time ($T_c = \Sigma\ x.\ l_x.m_x / \Sigma\ l_x.m_x$) and capacity for increase ($r_c$) were calculated. The intrinsic rate of increase ($r_m$) was

Table 3 : Age specific life table of *C.binotalis* for the second generation on mustard during rabi 2000- 2001

| Stage of insect (x) | Number living at the beginning ($l_x$) | Factor responsible for dx (dfx) | Number dying during x (dx) | dx as a per cent of $l_x$ (100 qx) | Survival rate with in x ($S_x$) | Log $l_x$ | K-value |
|---|---|---|---|---|---|---|---|
| Expected eggs | 116 | Sterility | 16 | 13.5 | | 2.0644 | 0.0644 |
| Viable eggs | 100 | | | | 0.86 | 2.0000 | |
| Period I Larvae ($N_1$) | 100 | Parasitoids | 23 | 23.00 | | 2.0000 | 0.1136 $k_1$ |
| | 77 | Predators | 2 | 2.00 | | 1.8864 | 0.0114$k_2$ |
| | 75 | Unknown | 22 | 22.00 | | 1.8750s | 0.1508$k_3$ |
| | 53 | Subtotal | 47 | 47.00 | 0.53 | 1.7242 | 0.2753 |
| Period II Larvae | 53 | Parasitoids | 7 | 13.20 | | 1.7242 | 0.0615 $k_4$ |
| | 46 | Predators | 2 | 3.77 | | 1.6627 | 0.0193$k_5$ |
| | 44 | Diseases | 3 | 5.66 | | 1.6434 | 0.0307$k_6$ |
| | 41 | Unknown | 9 | 16.98 | | 1.6127 | 0.1076$k_7$ |
| | 32 | Subtotal | 21 | 39.61 | 0.60 | 1.5051 | 0.2191 |
| Period III Larvae | 32 | Parasitoids | 4 | 12.50 | | 1.5051 | 0.0580$k_8$ |
| | 28 | Unknown | 5 | 15.62 | | 1.4471 | 0.854$k_9$ |
| | 23 | Subtotal | 9 | 28.12 | 0.71 | 1.3617 | 0.1434 |
| Pupa | 23 | Parasitoids | 2 | 8.69 | | 1.3617 | 0.0395$k_{10}$ |
| | 21 | Fail to emerge | 4 | 17.39 | | 1.3222 | 0.0918$k_{11}$ |
| | 17 | Subtotal | 6 | 26.08 | 0.73 | 1.2304 | 0.1313 |
| Adults | 17 | | | | | | K = 0.8335 |

Sex Ratio = 1.13 : 1.00;
Average fecundity = 236 eggs/ female
Number of females x average fecundity ($N_2$) = 1888
Female x 2 ($N_3$) = 16
Trend index (I) $N_2/N_1$ = 18.88
Generation survival (SG) $N_3/N_1$ = 0.16

calculated by taking two arbitrary trial values of '$r_c$' differing one point in second decimal place and substituted in the $e^{7-r_m x}.l_x.m_x$ equation. The trial values on Y-axis and summation values on X-axis were plotted on the graph. The points of trial values against summation were connected with a straight line. The point on the straight line at which it intercepted with the vertical line drawn from the established value, 1096.6 from axis was considered as the accurate '$r_m$' value the following parameters were derived by using the formulae given by Atwal and Bains, 1974.

Corrected generation time (T) = $\log_e r_0/r_m$

Finite rate of increase ($\lambda$) = anti $\log_e r_m$

Weekly multiplication rate ($\lambda^7$) = $(e^{rm})^7$

Doubling time (DT) = $\log_e 2/r_m$

Table 4 : Age specific fecundity table of C. *binotalis* for second generation :

| | | | | | Trial $r_m$ | | Accurate $r_m$ |
|---|---|---|---|---|---|---|---|
| Pivotal age in days (x) | $l_x$ | $m_x$ | $l_x m_x$ | $x.l_x m_x$ | 0.06 | 0.07 | 0.0609 |
| | | | | | $e^{7-rmx}.l_x m_x$ | $e^{7-rmx}.l_x m_x$ | $e^{7-rmx}.l_x m_x$ |
| 29 | 0.07 | | | | | | |
| 30 | 0.07 | 4.9535 | 0.3467 | 10.4023 | 62.84 | 46.55 | 61.17 |
| 31 | 0.07 | 12.7727 | 0.8940 | 27.7167 | 152.61 | 111.93 | 148.42 |
| 32 | 0.07 | 16.3181 | 1.1422 | 36.5525 | 183.63 | 133.34 | 178.42 |
| 33 | 0.07 | 24.6875 | 1.7281 | 57.0281 | 261.65 | 188.10 | 253.09 |
| 34 | 0.07 | 21.6363 | 1.5145 | 51.4943 | 215.95 | 153.71 | 209.45 |
| 35 | 0.05 | 18.6843 | 0.9342 | 32.6975 | 125.45 | 88.40 | 121.56 |
| 36 | 0.04 | 16.4572 | 0.6582 | 23.6983 | 83.24 | 58.07 | 80.58 |
| 37 | 0.02 | 19.0358 | 0.3807 | 14.0864 | 45.34 | 31.31 | 43.85 |
| 38 | 0.00 | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| Total | | 134.54 | 7.5896 | 253.6761 | 1130.71 | 811.41 | 1096.54 |

Net reproductive rate ($r_0$) = 7.5896
Mean duration of generation ($T_c$) = 33.42 days
Capacity for increase ($r_c$) = 0.0606
Intrinsic rate of increase ($r_m$) = 0.0609
Finite rate of increase ($\lambda$) = 1.0628
Weekly multiplication rate ($\lambda^7$) = 1.5316
Corrected generation Time (T) = 32.28 days
Doubling time (DT) = 11.38 days

## RESULTS AND DISCUSSION

The data (Table 1 and 3) showed that the major mortality factor during egg stage was infertility or sterility of eggs. The mortality was low during the egg stage which was in confirmity with Sastrosiswojo and Setiawati (1990).

In both the generations, parasitoids caused higher percentage mortality in period-I larvae (24.00 and 23.00%) when compared to unknown factors. In addition predators were also observed as mortality factor on C. *binotalis* to some extent. In period-II larvae, diseases were observed to cause 5.66% mortality during second generation, but it was absent in first generation. It may be due to high relative humidity prevailing during the second generation. However, unknown factors and parasitoids were the major mortality factors during larval phase. But in pupal stage, failure of adult emergence was observed as major mortality factor which was in agreement with Reddy (1995).

Among the different mortality factors unknown factors were observed as key mortality factor against C. *binotalis* in both the generations with K-values of 0.30 and 0.3438 during first and second generations, respectively followed by parasitoids (Table 1 and 3).

From the results (Table 1 and 3) it is evident that the period-I larvae are more vulnerable to natural mortality factors with the

Fig : 1 Determination of intrinsic rate of increase ($r_m$) of C.binotalis for the first generation

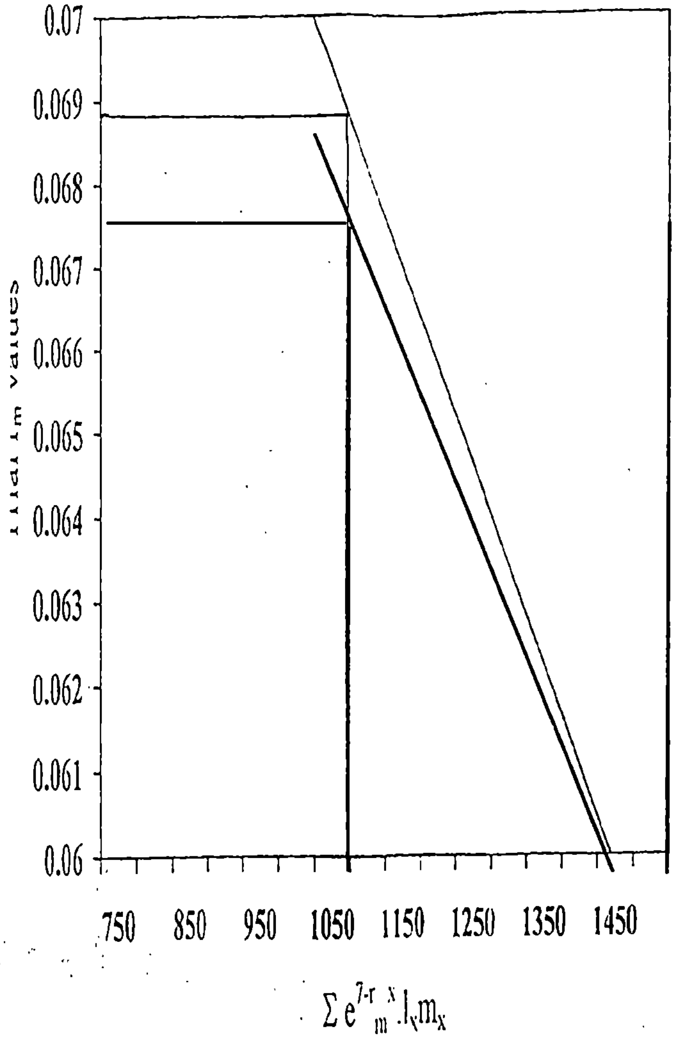
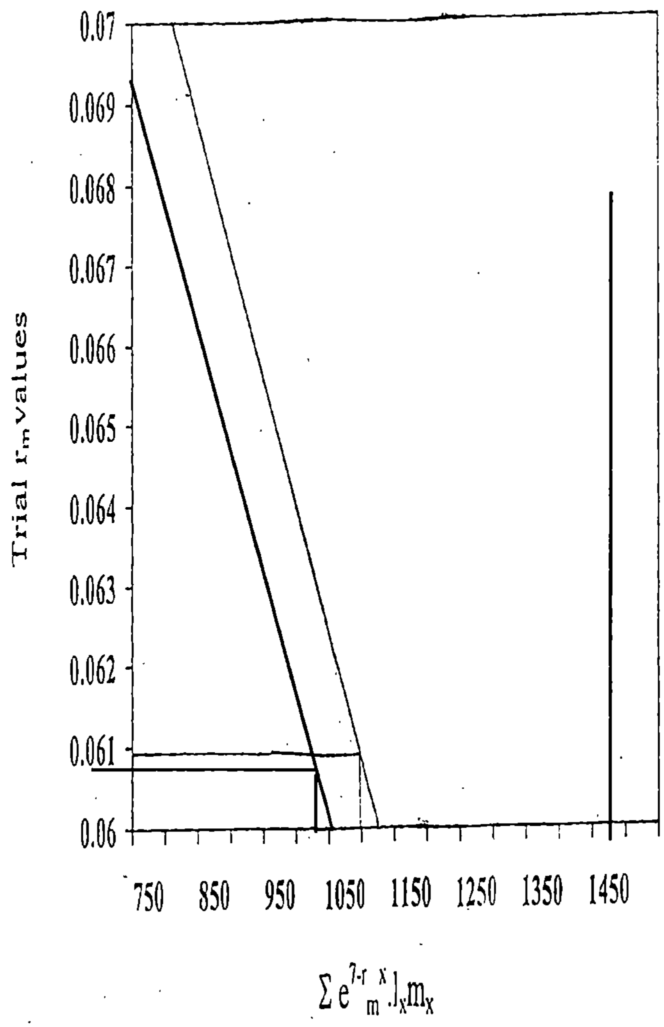


Fig : 2 Determination of intrinsic rate of increase ($r_m$) of C.binotalis for the second generation



lowest survival rate ($S_x$) and the highest K-value in both the generations. The total K-value in the first generation was 0.7705 as against 0.8335 during the second generation (Table 1 and 3) which indicated high killing power of all the mortality factors in the second generation.

The sex ratio for male to female was 1.09 : 1.0 in the first generation and 1.13 : 1.0 in the second generation which indicated high density of males in both the generations which was in agreement with Reddy and Ali (1975). The average fecundity was 204 and 236 eggs per female in first and second generations, respectively. The maximum egg laying was observed on fifth day after emergence in both the generations.

The trend index was positive and very high in both the generations, which indicated that the natural mortality factors operating in mustard ecosystem were not effective in suppressing the pest population of *C.binotalis*. Similar results were obtained by Reddy (1995). The generation survival ($S_G$) indicated that comparatively higher percentage of individuals completed their generation successfully.

The data (Table 2 and 4) indicated that the net reproductive rate ($r_0$) was high in first generation (9.66) when compared to second generation. The expected rates of increase *viz.*, capacity for increase ($r_c$), intrinsic rate of increase ($r_m$), finite rate of increase ($\lambda$) and weekly multiplication rate ($\lambda^7$) were high in the first generation when compared to the second generation. The intrinsic rate of increase ($r_m$) was 0.0688 (Fig 1) in the first generation as against 0.0609 females/ female / day (Fig 2) in the second generation. The results were in close agreement with Reddy *et al.* (1997). The corrected generation time was around 33.00 days in both the generations (Table 2 and 4). The population doubling time (DT) was low in the first generation which was 10.07 days as against 11.38 days in the second generation which indicated quick multiplication of individuals in the first generation (Table 2 and 4) which might be due to low temperatures prevailing during the second generation.

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(Received on 19-04-2003 and revised on 20-05-2003)

*The Andhra Agric.* J. **50** (3&4) : 276 - 278, 2003

# Classification of Certain Chickpea Genotypes Based on The Incidence of *Helicoverpa armigera* (Hubner)

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## ABSTRACT

Studies were conducted to find out a promising chickpea genotype based on the pod borer *Helicoverpa armigera* incidence and yield parameters. The results indicated that among the early and medium duration variety groups, ICC 506 and ICCL 86111 were found as promising genotypes based on lower incidence and pod damage level besides recording higher yields.

**Key words :** Chickpea Genotypes, *Helicoverpa armigera*

Grain yield of chickpea is generally reduced by different insect pests (Chhabra *et al.*, 1990) of which gram pod borer (*Helicoverpa armigera*) is a major insect pest. Surveys conducted by ICRISAT entomologists in India during the past 5 years recorded the pod damage in chickpea even to the extent of 84.4% in different states with a range of 3.4 to 59.5; 4.0 to 23.0 and 12.0 to 32.0% in short, medium and long duration varieties under unprotected conditions, respectively. Thus, different genotypes exhibited differential reactions to *Helicoverpa armigera* incidence based on duration of the genotype.

In view of this an attempt was made to classify the genotypes based on their incidence levels and yield potential vis-a-vis duration of the group.

## MATERIAL AND METHODS

The host plant resistance to the pod borer was studied in 16 chickpea genotypes and preliminary classification was done through two distinct ways i.e.,

1. by considering days to 50% flowering and
2. by calculating the mean and standard deviation of larval incidence, per cent pod damage and yield of different genotypes.

The percentage of pod damage was plotted against days to 50% flowering. The more resistant and susceptible genotypes can be distinguished as being those, that are farthest from regression lines as reported by Lateef *et al.* (1985).

The mean $(\overline{X})$ and standard deviation (S.D) of mean larval count, pod damage and yield were computed. A preliminary classification of genotypes was done considering the mean values as suggested by Shivalinga Swamy and Balasubramanian (1992) which were as follows :

### Larval Incidence

1. Promising genotypes with larval population less than $\overline{X}$ - S.D.
2. Susceptible genotypes with larval population between $\overline{X}$ - S.D. and $\overline{X}$ + S.D.
3. Highly susceptible genotypes with larval population more than $\overline{X}$ + S.D.

Table : Classification of genotypes based on mean and standard deviation of *Helicoverpa armigera* incidence, pod damage and yield during *rabi* 1997 - 98.

| Parameters | Promising genotypes | Susceptible genotypes | High susceptible genotypes |
|---|---|---|---|
| Larval number<br>Mean : 9.85<br>S.D. : 4 .1 | ICCV 7<br>ICCL 86111<br>ICCL 86102<br>ICC 506<br>ICCL 86104 | ICCL 86101<br>ICCV 93122<br>ICCV 2<br>ICCV 95992<br>ICCL 96106<br>L 550,<br>ICC 4958, ICCC 37<br>K 850, ICCV 10 | Annegeri |
| Per cent pod damage<br>Mean : 21.27<br>S.D. : 11.67 | ICCV 7<br>ICC 506<br>ICCL 86101<br>ICCL 86102<br>ICCL 86111 | ICCV 93122<br>ICCV 2<br>ICCL 86104<br>ICCV 10<br>ICCV 95992<br>K 850<br>ICCL 86106<br>L 550 | ICCC 37<br>ICC 4958<br>Annegeri |
| Yield<br>Mean : 13.58<br>S.D. : 3.92 | ICC 506<br>ICCL 86111 | ICCL 86101<br>ICCL 86102<br>ICCL 86104<br>ICCV 2<br>ICCV 7,<br>ICCV 10<br>ICCV 93122<br>ICC 4958<br>ICCC 37<br>ICCV 95992<br>Annegeri | K 850<br>L 550<br>ICCL 86106 |

**POD Damage**

1. Promising genotypes with pod damage (%) less than $\bar{X}$ - S.D.

2. Susceptible genotypes with pod damage percentage between $\bar{X}$ - S.D. and $\bar{X}$ + S.D.

3. Highly susceptible genotypes with pod damage percentage more than $\bar{X}$ - S.D.

**Yield (kg / ha)**

1. Promising genotypes with yield more than $\bar{X}$ + S.D.

2. Susceptible genotypes with yield between $\bar{X}$ + S.D. and $\bar{X}$ - S.D.

3. Highly suspectible genotypes with yield less than $\bar{X}$ - S.D.

## RESULTS AND DISCUSSION

Grouping based on 50% flowering was done by comparing the percentage of damage vs. days to 50% flowering i.e., time to flowering as dipicted in Fig. 1. The data reveals ICCV 7 was the most resistant genotype among the early maturing genotypes followed by ICCL 86101, ICC 506, ICCL 86102 and ICCL 86104. Among the medium duration genotypes ICCL 86111 was the most resistant, while all the long duration genotypes are susceptible to pest attack. Pest

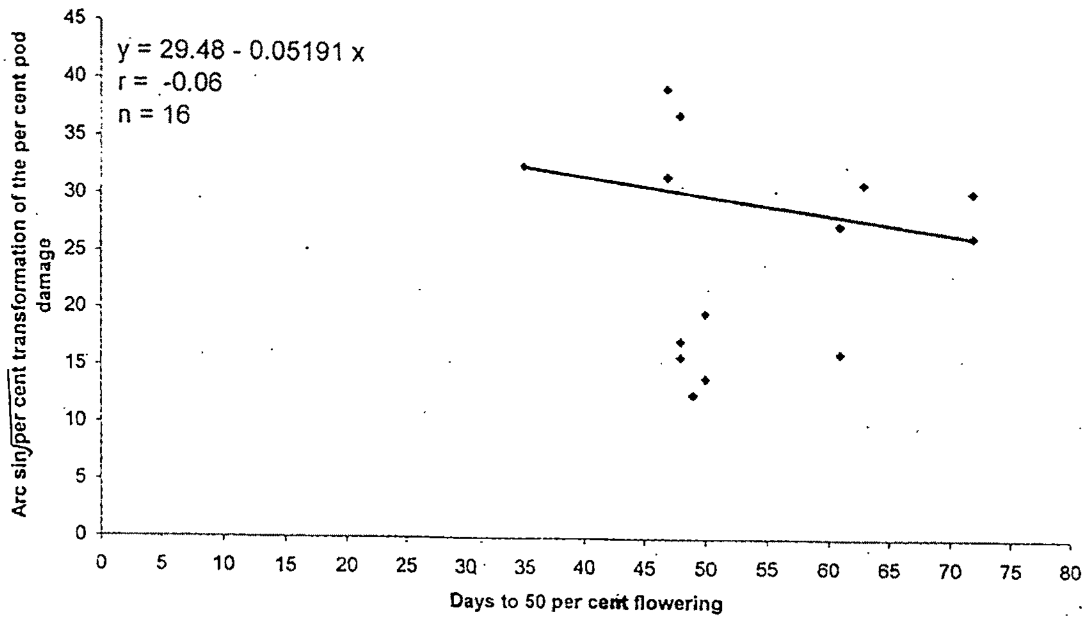

**Fig. 4** Linear regression of arc sin√per cent transformation of pods damaged (per cent) and time to 50 per cent flowering of the chickpea genotypes

avoidance was the main mechanism involved in host plant resistance in the early and medium duration groups. ICC 506 and other genotypes have been found to be constantly resistant to *H. armigera* (Patnaik and Mahapatro, 1995).

The mean ($\overline{X}$) and standard deviation (S.D.) of larval incidence, per cent pod damage and yield (kg/ha) were utilized to group the genotypes as promising genotypes and the results are presented in Table 1.

The results indicated that ICC 506 and ICCL 86111 were the promising genotypes against *H. armigera* in *rabi* season when all the three factors i.e., larval incidence, pod damage and yield parameters were taken into consideration among the early and medium maturity groups, respectively. These observations are in agreement with Lateef (1985) who suggested the selection of varieties based on reduced susceptibility and greater yield compared to their local standard checks.

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(Received on 21-08-2000 and revised on 29-12-2000)

*The Andhra Agric.* J. **50** (3&4) : 279 - 282, 2003

# Seasonal Abundance and Influence of Weather Parameters on The Incidence of *Helicoverpa armigera* (Hubner) Hardwick Infesting Chickpea

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## ABSTRACT

A study on the seasonal incidence of *Helicoverpa armigera* (Hubner) Hardwick on Annigiri cultivar of chickpea was carried out at Agricultural College Farm, Bapatla during *rabi* 2001 -2002. Multiple correlation studies were undertaken to understand the influence of weather factors on the population build up of *H. armigera*. The peak pest activity was found at the end of second fortnight of January till the middle of February. The incidence of gram pod borer revealed significant positive association with minimum temperature, morning relative humidity and evening relative humidity while maximum temperature and sunshine hours showed negligible influence on larval incidence.

**Key words :** Seasonal Abundance,Weather Parameters, *Helicoverpa armigera*

Chickpea (Cicer *arientinum* L.) is the third most important legume crop in the world. Although chickpea crop is attacked by nearly 57 species of insect and other arthropods in India (Lal, 1992), *Helicoverpa armigera* (Hub.) alone accounts for about 90 to 95 per cent of the total damage caused by all the insect pests (Sachan ad Katti, 1994). Although, a wealth of documented work on various aspects of *H. armigera* in chickpea is available, there remains many lacunae, particularly in the areas of seasonal incidence, influence of weather factors which would go a long way in managing the pest effectively which are greatly useful in planning timely control measures. As a part of unraveling the role of different abiotic factors on the temporal demarcation of the incidence of gram pod borer, investigations were undertaken to understand the relationship between the incidence of the gram pod borer on chickpea and the weather parameters.

## MATERIAL AND METHODS

The population build up of *H. armigera* and its seasonal incidence was studied during *rabi* 2001 - 2002 at Agricultural College Farm, Bapatla. A bulk plot of 100 $m^{-2}$ adopting 30 cm x 10 cm spacing was raised. The incidence of the gram pod borer was recorded soon after noticing initial infestation of the pest and continued upto maturity of the crop at weekly intervals on 50 randomly selected and tagged plants at five different places (10 plants at each place). The number of larvae per plant was counted at each observation and recorded regularly. The meteorological data available at the College Farm, Bapatla was collected and correlated with the incidence of the gram pod berer to work out the relationship between the incidence and the weather parameters. Simple correlation and multiple regression analysis was adopted. Among the weather parameters morning relative humidity, evening relative

Table 1 : Influence of weather parameters on the incidence of gram pod borer on chickpea during *rabi* 2001 - 2002 .

| Date of observation | Mean Number of larvae per 10 plants | Temperature (°C) Max. ($X_1$) | Temperature (°C) Min. ($X_2$) | Relative Humidity Morning ($X_3$) | Relative Humidity Evening ($X_4$) | Sunshine hours ($X_5$) |
|---|---|---|---|---|---|---|
| 10th December | 0 | 30.02 | 15.0 | 85.7 | 50.1 | 8.11 |
| 17th December | 0 | 30.50 | 14.8 | 90.1 | 47.7 | 6.42 |
| 24th December | 0.6 | 29.20 | 15.1 | 91.4 | 50.1 | 8.17 |
| 1th January | 3 | 29.20 | 15.8 | 91.5 | 50.7 | 8.11 |
| 8th January | 4.4 | 29.50 | 16.2 | 92.5 | 52.7 | 7.57 |
| 15th January | 5.8 | 30.0 | 16.2 | 91.1 | 51.5 | 7.5 |
| 22nd January | 8.4 | 29.2 | 17.0 | 93.4 | 54.5 | 7.02 |
| 29th January | 11.4 | 31.2 | 20.8 | 93.7 | 58.2 | 7.55 |
| 5th February | 11 | 31.2 | 19.8 | 90.2 | 57.2 | 9.3 |
| 12th February | 10.4 | 31.7 | 19.2 | 89.6 | 52.0 | 8.2 |
| 19th February | 8 | 31.82 | 18.6 | 88.7 | 52.4 | 7.18 |
| 26th February | 4.2 | 32.01 | 16.7 | 85.4 | 45.0 | 8.04 |
| 5th March | 1.2 | 32.10 | 18.1 | 86.2 | 42.7 | 7.02 |

humidity, maximum temperature, minimum temperature and sunshine hours were considered for correlating with the incidence of the pod borer.

## RESULTS AND DISCUSSION

The data recorded on the incidence of the gram pod borer population at weekly intervals revealed that the initial occurrence of *H. armigera* was during the last week of December. The first observation made on 24-12-2001 (20 days after sowing) showed a mean number of 0.6 larvae per 10 plants. The gram pod borer incidence continued to be low upto the flower initiation stage of the crop (35 days after sowing). The highest larval incidence was observed during the last week of January (29-1-2002) i.e. at 55 days after sowing with 11.4 larvae per 10 plants. The peak incidence continued till the end of first fortnight of February (12-2-2002) i.e. upto 70 days after sowing and thereafter there was a gradual decline with 1.2 larvae per 10 plants by the first week of March (5-3-2002) i.e. 90 days after sowing, a few days prior to harvest.

The larval incidence showed an increasing trend starting from the first fortnight of January 2002 (Table 1) coinciding with the maximum flowering and pod formation stage followed by a gradual decline after second fortnight of February and finally the population disappeared by first week of March when the crop reached harvesting stage. The present findings are in confirmity with the studies of Yadav *et al.* (1986) and Bapodara (1988), who also reported the pest activity from December to March. It is evident from these studies, that late sown chickpea (December) which matures by March faces peak density of the pod borer population and the crop suffers the maximum damage. This is in line with the reports of Lal *et al.* (1986) and Borah (1998).

Table 2 : Multiple linear regression analysis of number of larvae of *H. armigera* with weather parameters

| Variable | Regression coefficient | Standard error | 't' value |
|---|---|---|---|
| $X_1$ - Maximum temperature (°C) | -8.3133 | 5.6749 | 1.4649 |
| $X_2$ - Minimum temperature (°C) | 16.7880** | 4.3534** | 3.8562** |
| $X_3$ - Morning Relative Humidity (%) | 9.9830** | 1.8145** | 5.5017** |
| $X_4$ - Evening Relative Humidity (%) | 3.4589** | 0.7785** | 4.4427** |
| $X_5$ - Sunshine hours | -9.3523 | 5.3470 | 1.7490 |

Intercept (a) = -1009.064 Fcal value = 9.5011

Per cent of variation attributable to the regression ($R^2$) = 0.8715

** Significant at 1% level

Regression equation obtained from Table 2

$$Y = -1009.064 - 8.3133\,x_1 + 16.7880\,x_2^{**} + 9.9830\,x_3^{**} + 3.4589\,x_4^{**} - 9.3523\,x_5$$

Table 3 : Partial regression coefficient of gram pod borer incidence and weather factors

| Variable | By minimum temperature morning relative humidity and evening relative humidity | By all weather factors |
|---|---|---|
| Number of larvae per 10 plants | $R^2$ | |
| | 0.8039 | 0.8715 |

Studies on the interaction between the pest incidence and the abiotic components have indicated that the coefficient of determination ($R^2$ = 0.8715) (Table - 3) was influenced by the climatic factors to the extent of 87.15 per cent out of which the significant partial regression coefficients *viz.*, minimum temperature, morning relative humidity and evening relative humidity contributed to the extent of 80.39 per cent (Table - 3) whereas maximum temperature and sunshine hours had a negligible effect on the larval incidence (Table 2). The results are in agreement with the observations of Yadava (1990) who reported significant positive correlation between the prevailing temperature and the larval incidence of *H. armigera*. The low larval incidence of *H. armigera* observed during the end of December to January was due to the prevailing low temperature and these observations are in agreement with the findings of Saini and Jaglan (1998). However, the present findings on seasonal activity of the gram pod borer with respect to temperature do not agree with the findings of Patnaik and Senapati (1996) from Orissa who reported a significant negative correlation between the mean maximum and minimum temperature and the larval incidence on chickpea. Hence, it is evident from these studies, that the late sown chickpea (December) which matures by March, faces peak density of the pod borer population and the crop suffers the maximum damage. This information on the seasonal occurrence of the pest with reference to favourable stage of the crop growth suitable for breeding as well as feeding will give a definite clue about the level of activity. This knowledge may be utilised to adjust the sowing date or to make acceptable modification in the cropping system and also to time the various approaches for the control to have an ecologically sound method to check the pest.

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(Received on 30-12-2002 and revised on 23-08-2003)

*The Andhra Agric.* J. 50 (3&4) : 283 - 286, 2003

# Effect of Different Levels of Zinc on Yield and Yield Components of Different Rice Hybrids

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## ABSTRACT

A pot culture experiment was conducted to study the yield and yield components of different rice hybrids (MTUMR-2041, MTUHR-2048, OHRT - 152, APHR-2 and MTUHR-2040) by different zinc levels (0, 25 , 50 and 75 kg ha$^{-1}$) during the *rabi* 2000 - 2001. Application of 25 kg $ZnSO_4$ ha$^{-1}$ improved significantly the grain yield by increasing the number of panicles hill$^{-1}$, number of spikelets panicle $^{-1}$, number of filled grains panicle $^{-1}$ and test weight. The hybrids MTUHR-2041 and MTUHR-2048 showed significant and maximum increase in grain yield.

**Key words :** Zinc, Yield Components, Rice Hybrids.

Balanced nutrient management and high yielding varieties are important for increasing the rice productivity. India has emerged as second country after China and made good progress in development of high yielding rice hybrids. For full exploitation of rice hybrids it is necessary to develop special management practices that promote efficient use of water and nutrients. To obtain maximum benefit from fertilisation, more attention should be paid to the inclusion of micro nutrients in rice fertiliser recommendations along with N, P and K. Zn deficiency has been reported to be most wide spread micro nutrient disorder, which limits rice yields. Strong varietal differences may exist in the efficiency of Zn utilisation. Therefore an attempt is necessary to find out the variation in rice hybrids for Zn utilisation at different levels of Zn. Hence this investigation was conducted to find out the productive efficiency of rice hybrids at different levels of $ZnSO_4$.

## MATERIAL AND METHODS

Studies on the effect of different levels of zinc on the yield and yield parameters of different rice hybrids were carried out at Agricultural College, Bapatla. The pot culture experiment was laid out in randomised block design with factorial concept, using three replications during the *rabi* 2000 - 2001. Nursery was raised in separate pots at the rate of 5 gm pot$^{-1}$. The experiment comprised of four Zn levels of 0, 25, 50 and 75 kg $ZnSO_4$ ha$^{-1}$ and five rice hybrids viz., MTUMR-2041, MTUHR-2048, OHRT - 152, APHR-2 and MTUHR-2040. The soil of vertisol nature (pH 8.3, E.C. 0.7, dSm$^{-1}$, organic carbon 0.5%, available nitrogen 204 kg ha$^{-1}$, available phosphorus ($P_2O_5$) 18 kg ha$^{-1}$, available potassium ($K_2O$) 627 kg ha$^{-1}$ used in this experiment. Each pot received a uniform application of N, $P_2O_5$ and $K_2O$ as per the recommended schedule (120, 60 and 40 kg ha$^{-1}$ N, $P_2O_5$ and $K_2O$ respectively) in the form of urea, single super phosphate and muriate of potash respectively. A dose of 1/3 N, total $P_2O_5$ and 1/2 $K_2O$ was applied as basal dressing and the remaining doses of N were applied in two equal splits, one to active tillering and second at panicle initiation stages. Remaining dose of $K_2O$ was

Table 1 : Effect of Zn levels on yield components of five rice hybrids.

| Treatments | No. of Panicles hill$^{-1}$ | Length of Peduncle (cm) | No. of spikelets Panicle $^{-1}$ | No. of filled grains Panicle $^{-1}$ | No. of unfilled grains Panicle $^{-1}$ | Test weight (g) |
|---|---|---|---|---|---|---|
| **Hybrids** | | | | | | |
| V1 - MTUHR - 2041 | 11.60 | 25.41 | 115.80 | 109.58 | 6.41 | 23.70 |
| V2 - MTUHR - 2048 | 10.66 | 22.24 | 108.50 | 100.16 | 8.41 | 19.64 |
| V3 - OHRT - 152 | 9.83 | 20.87 | 102.30 | 95.33 | 7.00 | 18.12 |
| V4 - APHR - 2 | 13.83 | 24.67 | 76.16 | 61.08 | 15.08 | 20.64 |
| V5 - MTUHR - 2040 | 12.25 | 23.04 | 120.58 | 112.83 | 8.25 | 21.40 |
| SEm ± | 0.29 | 0.27 | 1.99 | 2.08 | 0.40 | 0.31 |
| CD (0.05) | 0.81 | 0.75 | 5.52 | 5.77 | 1.12 | 0.87 |
| **Levels of $ZnSO_4$** | | | | | | |
| T1- 0 kg ha$^{-1}$ | 10.80 | 22.07 | 97.20 | 89.33 | 8.26 | 20.75 |
| T2- 25 kg ha$^{-1}$ | 13.20 | 24.23 | 117.00 | 108.13 | 8.86 | 20.64 |
| T3- 50 kg ha$^{-1}$ | 12.33 | 23.33 | 107.80 | 98.73 | 9.20 | 20.76 |
| T4- 75 kg ha$^{-1}$ | 10.26 | 23.36 | 96.80 | 87.00 | 9.80 | 20.65 |
| SEm ± | 0.26 | 0.24 | 1.78 | 1.86 | 0.36 | 0.28 |
| CD (0.05) | 0.73 | 0.67 | 4.94 | 5.16 | 1.00 | NS |
| **Interaction** | | | | | | |
| V1T1 | 10.00 | 23.90 | 105.00 | 98.33 | 6.66 | 23.63 |
| V1T2 | 14.33 | 26.70 | 131.33 | 124.66 | 6.66 | 23.16 |
| V1T3 | 12.33 | 25.53 | 118.00 | 111.66 | 7.00 | 25.43 |
| V1T4 | 10.00 | 25.53 | 109.00 | 103.66 | 5.33 | 22.56 |
| V2T1 | 9.33 | 21.53 | 97.66 | 89.33 | 8.33 | 19.46 |
| V2T2 | 12.66 | 22.90 | 113.66 | 105.33 | 8.33 | 19.76 |
| V2T3 | 11.00 | 22.70 | 121.00 | 113.00 | 8.00 | 19.86 |
| V2T4 | 9.66 | 22.03 | 102.00 | 93.00 | 9.00 | 19.46 |
| V3T1 | 10.00 | 21.26 | 96.66 | 90.66 | 6.00 | 17.90 |
| V3T2 | 10.66 | 21.66 | 121.00 | 114.33 | 6.66 | 18.03 |
| V3T3 | 9.33 | 21.83 | 101.00 | 94.00 | 7.00 | 17.96 |
| V3T4 | 9.33 | 18.73 | 90.66 | 82.33 | 8.33 | 18.60 |
| V4T1 | 15.33 | 23.40 | 66.66 | 53.66 | 13.00 | 20.33 |
| V4T2 | 13.33 | 26.06 | 91.00 | 76.00 | 15.00 | 21.40 |
| V4T3 | 15.00 | 23.73 | 78.33 | 93.00 | 15.33 | 20.43 |
| V4T4 | 11.66 | 25.50 | 68.66 | 51.66 | 17.00 | 20.40 |
| V5T1 | 9.33 | 20.46 | 120.00 | 114.66 | 7.33 | 22.43 |
| V5T2 | 15.00 | 23.83 | 128.00 | 120.33 | 7.66 | 20.83 |
| V5T3 | 14.00 | 22.86 | 120.66 | 112.00 | 8.66 | 20.10 |
| V5T4 | 10.66 | 25.00 | 113.66 | 104.33 | 9.33 | 22.23 |
| SEm + | 0.58 | 0.54 | 3.98 | 4.16 | 2.07 | 0.63 |
| CD (0.05) | 1.63 | 1.51 | NS | NS | NS | NS |
| CV (%) | 8.75 | 4.06 | 6.59 | 6.59 | 15.52 | 5.29 |

NS : Non significant

Table 2 : Effect of Zn levels on Grain yield hill$^{-1}$ (g) of five rice hybrids.

| Levels of ZnSO$_4$ | Rice hybrids | | | | | Mean |
|---|---|---|---|---|---|---|
| | MTUHR - 2041 | MTUHR - 2048 | OHRT - 152 | APHR - 2 | MTUHR - 2040 | |
| T1- 0 kg ha$^{-1}$ | 10.75 | 14.03 | 8.82 | 9.16 | 11.38 | 10.71 |
| T2- 25 kg ha$^{-1}$ | 20.80 | 19.70 | 11.07 | 12.80 | 15.00 | 15.87 |
| T3- 50 kg ha$^{-1}$ | 16.39 | 15.67 | 9.62 | 11.49 | 13.50 | 13.35 |
| T4- 75 kg ha$^{-1}$ | 13.82 | 14.43 | 8.57 | 9.62 | 12.10 | 11.84 |
| Mean | 15.44 | 15.96 | 9.37 | 10.77 | 13.19 | |

| | SEm ± | CD (0.05) | CV (%) |
|---|---|---|---|
| Hybrids | 0.23 | 0.64 | 6.26 |
| Zn levels | 0.20 | 0.58 | |
| Interaction | 0.46 | 1.29 | |

applied at panicle initiation stage. Total Zn was applied as basal dressing. For recording observations like yield and yield components, plants were randomly selected and then averages were calculated. Plants were sundried before recording the observations. Data collected were analysed statistically by following factorial randomised block design (Panse and Sukhatame, 1957).

## RESULTS AND DISCUSSION

The results on the effect of different levels of zinc on yield and yield components of different rice hybrids are furnished and discussed here under.

The hybrids differed significantly in grain yield hill$^{-1}$. The highest number of panicles hill$^{-1}$ was observed in APHR-2 with less number of grains panicle$^{-1}$ and yield hill$^{-1}$. The yield of APHR-2 was 42.3% and 48.2% lesser than that of MTUHR-2041 and MTUHR-2048 respectively. The less grain yield hill$^{-1}$ in APHR-2 could be attributed to its less number of grains panicle$^{-1}$ coupled with more number of unfilled grains panicle$^{-1}$. The lowest number of panicles hill$^{-1}$ was observed in OHRT-152 with less number of grains panicle$^{-1}$, number of unfilled grains panicle$^{-1}$ and 1000 grain weight. Yield hill$^{-1}$ was minimum in OHRT - 152 compared to other four hybrids and it could be attributed to less number of panicles hill$^{-1}$, number of grains panicle$^{-1}$ and 1000 grain weight. The second lowest number of panicles hill$^{-1}$ was observed in MTUHR - 2048 but yield hill$^{-1}$ was maximum because the number of grains panicle$^{-1}$, filled grains panicle$^{-1}$ was higher than that of APHR-2 and OHRT - 152. The highest grain yield hill$^{-1}$ was observed in both MTUHR-2048 and MTUHR-2041 and it could be attributed to more number of grains panicle$^{-1}$, filled grains panicle$^{-1}$, 1000 grain weight and less number of unfilled grains panicle$^{-1}$.

Maximum yield was recorded with the application of 25 kg ZnSO$_4$ ha$^{-1}$ and it was 48.2% higher than that of control. Number of panicles hill$^{-1}$, number of grains panicle$^{-1}$, number of filled grains panicle$^{-1}$ and length of peduncle were also the highest with the application 25 kg ZnSO$_4$ ha$^{-1}$. Similar findings were reported by Tomar *et al.* (1994), Ram *et al.* (1995), Agarwal and Surajbhan (1997), Patil *et al.* (1997) and Chaphale and Badole (1999) in rice. The increase in yield due to Zn application to the soil could possibly be due to enhanced synthesis of carbohydrates, active absorption of nutrients and canalisation of photosynthates to the storage organs. The interaction between rice hybrids and levels of Zn also influenced the yield components i.e. number of panicles hill$^{-1}$, yield and length of peduncle. In all rice hybrids, application of 25 kg $ZnSO_4$ ha$^{-1}$ resulted in the highest number of panicles hill$^{-1}$, yield and length of peduncle. But in APHR-2, Zn application had no effect on number of panicles hill$^{-1}$.

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(Received on 28-12-2002 and revised on 22-12-2003)

*The Andhra Agric.* J. **50** (3&4) : 287 - 290, 2003

# Efficacy of Plant Extracts in The Management of Collar Rot of Groundnut (*Arachis hypogaea* Linn.) Caused by *Aspergillus niger* V. Teighem

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## ABSTRACT

Seven plant extracts *viz., Bougainvillia* labra, *Polyalthia longifolia, Vinca rosea, Azadirachta indica, Allium sativum* and *Rawolfia serpentena* were tested for their effect on *Aspergillus niger v.* Teighem, the causal organism of collar rot of groundnut. Extracts of *Azadirachta indica, Polyalthia longifolia* and *Bougainvillia labra* at 10 per cent concentration were found to be effective in checking the growth and spore germination and were also found effective in reducing collar rot infection when used as seed treatment.

**Key words :** Plant Extracts, Collar Rot, *Aspergillus niger.*

Crown rot or collar rot of groundnut caused by *Aspergillus niger v.* Teighem is reported throughout the world (Feakin, 1973). Pre-emergence rotting of the seeds due to the fungus is common. Seed borne nature of the fungus has been well documented (Jackson, 1964; Ashworth, 1963). Controlling the disease by the use of plant extracts is one of the cheapest options and the fungitoxicity of the plant extracts on *Aspergillus niger* has been earlier reported (Sharma *et al.,* 1998; Saxena and Tripati, 1985). In view of the escalating cost of fungicides and also ecological hazards associated with chemicals used in the disease management the present study has been undertaken to find the effect of different plant extracts on growth and spore germination of *Aspergillus niger in vitro.* and also in the management of collar rot disease when used as seed treatment.

## MATERIAL AND METHODS

Groundnut seeds of variety TMV-2 were used for the present study. The experiments were carried out at Department of Plant Pathology, Agricultural College, Bapatla.

### Preparation of leaf extract

Fresh plant material of different plant species were thoroughly cleaned, surface sterilized with ethanol and washed well with sterile water. The plant tissue was ground with sterile water at the rate of 1ml/g of plant tissue using a pestle and mortar, and the macerate was filtered through a muslin cloth to get the crude extract. The crude extract of each plant species was diluted with sterile water to obtain separate extracts of 2,5 and 10 per cent concentration.

### Testing plant extracts on growth and spore germination of *A. niger*

Extracts of each plant species at each of the three concentrations were tested for their effect against the growth of *Aspergillus niger* by poisoned food technique (Nene and Thapliyal, 1971). The rapid growth of fungal colony was measured regularly and the per cent inhibition was calculated.

Table 1 : Effect of Plant extracts on the growth of *Aspergillus niger in vitro.*

| Plant extract | Colony Diameter * (cm)<br>Concentration of Plant Extract used<br>2% | <br><br>5% | <br><br>10% | Mean |
|---|---|---|---|---|
| *Bougainvillia labra* | 2.48 | 1.87 | 1.53 | 1.96 |
| *Allium sativum* | 8.07 | 7.67 | 7.42 | 7.72 |
| *Azadirachta indica* | 4.40 | 3.52 | 2.83 | 3.58 |
| *Polyalthia longifolia* | 4.95 | 4.55 | 2.28 | 3.93 |
| *Rawolfia serpentena* | 6.32 | 3.90 | 2.65 | 4.29 |
| *Vinca rosea* | 6.42 | 4.75 | 3.35 | 4.84 |
| Control | 8.45 | 8.48 | 8.48 | 8.47 |
| Mean | 5.87 | 4.96 | 4.08 | |

| | SEM ± | CD (0.05) |
|---|---|---|
| Plant extract | 0.06 | 0.16 |
| Concentration | 0.09 | 0.24 |
| Interacton | 0.10 | 0.28 |

* mean of three replications.

$$\% \text{ Inhibition} = \frac{\text{Radial growth in control - Radial growth in treatment}}{\text{Radial growth in control}} \times 100$$

The plant extracts were tested for their efficacy in inhibiting spore germination of *Aspergillus niger* by incubating a drop of each plant extract at each concentration along with a drop of spore suspension of *Aspergillus niger* in a cavity slide. A spore was considered to have germinated if germ tube was more than half the length of the long axis of the spore.

Three replications were maintained for each treatment at each concentration. Observations for growth were taken up to 7 days and observations on spore germination were taken 15 h after incubation.

**Testing plant extracts against collar rot**

To test the efficacy of different plant extracts on the development of collar rot of groundnut, seeds were treated with spore suspension of *Aspergillus niger* and air dried. The air dried seeds were separately treated with different plant extracts viz., *Bougainvillia labra, Polyalthia longifolia, Vinca rosea, Azadirachta indica, Allium sativum* and *Rawolfia sepentena* at 10 per cent concentration. The treated seeds were sown in earthen pots (30 x 30 cm) containing sterilized soil (Sand and FYM in the ratio of 3 : 1). Five replications were maintained for each plant extract used, each replication consisting of five seeds. Seeds treated with spore suspension alone served as control. Per cent collar rot infection was estimated 15 days after sowing.

$$\% \text{ Collar rot infection} = \frac{\text{No. of seedlings with collar rot infection}}{\text{No. of seedlings emerged}} \times 100$$

## RESULTS AND DISCUSSION

### *In vitro* studies

The results (Table 1) indicate that the plant extracts of *Bougainvillia labra* followed by *Azadirachta indica* and *Polyalthia longifolia* were

Table 2 : Effect of Plant extracts on spore germination of *Aspergillus niger in vitro.*

| Plant extract | Per cent spore germination | | | Mean |
|---|---|---|---|---|
| | Concentration of Plant extract used | | | |
| | 2% | 5% | 10% | |
| *Bougainvilia labra* | 30.74 | 26.81 | 16.47 | 24.67 |
| *Allium sativum* | 43.06 | 34.21 | 24.15 | 32.81 |
| *Azadirachta indica* | 26.08 | 22.70 | 12.51 | 20.43 |
| *Polyalthia longifolia* | 29.96 | 24.26 | 15.93 | 23.38 |
| *Rawolfia serpentena* | 27.88 | 21.96 | 14.45 | 21.43 |
| *Vinca rosea* | 21.23 | 18.48 | 12.05 | 17.25 |
| Control | 90.16 | 90.16 | 90.16 | 90.16 |
| Mean | 38.44 | 34.08 | 26.53 | |
| | SEM ± | CD (0.05) | | |
| Plant extract | 1.10 | 3.06 | | |
| Concentration | 0.72 | 2.00 | | |
| Interacton | 3.65 | 10.11 | | |

* mean of three replications.

Table 3 : Effect of seed treatment with plant extracts against collar rot infection in groundnut under artificial inoculation conditions.

| Plant extract | Concentration (%) | Per cent seed germination * | Per cent collar rot infection * |
|---|---|---|---|
| *Bougainvilia labra* | 10.0 | 55.00<br>(48.17) | 20.84<br>(20.35) |
| *Allium sativum* | 10.0 | 45.00<br>(41.83) | 37.50<br>(33.90) |
| *Azadirachta indica* | 10.0 | 52.50<br>(46.44) | 16.67<br>(17.92) |
| *Polyalthia longifolia* | 10.0 | 60.00<br>(50.77) | 33.33<br>(35.26) |
| *Rawolfia serpentena* | 10.0 | 50.00<br>(45.00) | 20.83<br>(20.35) |
| *Vinca rosea* | 10.0 | 55.00<br>(48.17) | 25.00<br>(22.79) |
| Control | | 30.00<br>(32.90) | 62.50<br>(56.11) |
| SEM ± | | 4.38 | 12.18 |
| CD (0.05) | | 13.02 | 36.19 |

* Mean of four replications

Figures in parenthesis are arc sine transformed values.

the most effective in inhibition of growth. The extracts of *Vinca rosea* and *Azadirachta indica* were effective on spore germination (Table 2). The extracts of *Allium sativum* was found to be the least effective on both growth and spore germination of *A. niger.* There was an increase in the effect of plant extract against the growth and spore germination of the fungus with the increase in the concentration of plant extract used. All extracts irrespective of plant species, at 10 per cent concentration significantly caused more reduction in the growth and spore germination of *A. niger* than at 5 per cent and 2 per cent concentration. The findings of the present study are in agreement with Sitansu *et al.* (1997), Sobti *et al.* (1995) and Narain and Satapathy (1978).

### *In vivo* studies

From the Table 3, it is evident that plant extracts used as seed treatment produced inhibitory effect on *A. niger* inoculated on the seed with the result the seed was not adversely affected. It is obvious that all the plant extracts except that of *Allium sativum* significantly increased the seed germination of groundnut over control. The extracts of *Polyalthia longfolia* was found to be the best recording 60.00 per cent germination followed by *Vinca rosea (55.00%), Bougainvillia labra (55.00%)* and *Azadirachta indica* (52.50%) as against 30.00 per cent seed germination in control. Extracts of *Azadirachata indica* was found to be the best in reducing the collar rot infection to 16.67 per cent as against 62.77 per cent in control.

Several workers reported the efficacy of *Azadirachta indica* against collar rot of groundnut (Bhore *et al.,* 1995; Bansal and Sobti, 1990). *Polyalthia longifolia* was also reported effective against collar rot disease (Sobti *et al.,* 1995). The fungitoxicity of the plants extracts found in the present study might be due to antifungal substances present in different plant species.

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(Received on 05-02-2001 and revised on 13-11-2001)

*The Andhra Agric.* J. **50** (3&4) : 291 - 294, 2003

# Correlation Between Components of Tree Size and Total Phenolics in Mango (*Mangifera indica* L.)

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## ABSTRACT

The character association between total phenolic content in bark of seven mango varieties of varying vigour during different growth stages and morphological characters were studied. There was positive correlation between tree size and shoot length, number of internodes and leaf area. while there was no correlation observed between internodal length and tree vigour. The total bark phenolic content during flowering and fruit growth showed significant negative correlations with vigour. Therefore, the characters shoot length, number of internodes per shoot and leaf area, bark phenolic content during flowering and fruit growth could be used as indicators in selecting the tree for their stature.

**Key words :** Correlation, Components, Phenolics

Mango (*Mangifera indica* L.) is the most important fruit of India and often refferred to as the king of fruits. However, Mango production in the worldwide are generally poor, ranging from 4 to 9 t ha$^{-1}$ (Oosthuyse., 1993). To increase mango production, one of the methods is to develop high yielding varieties of dwarf stature, so that more number of plants can be accommodated per unit area.

Among the various approaches to control tree size pruning, breeding of dwarfing root stocks, use of growth retardants and developing new polyembryonic root stocks (Iyer *et al.*, 1992). Development of dwarf varieties/ hybrids through breeding takes long time, one of the present day approaches is to find out endogenously produced chemicals responsible for dwarfing and to manipulate growth by their exogenous application.

A major hurdle in the field of tree size control is the lack of proper understanding of biochemical aspects that go into the determination of tree stature. Hence an attempt was made to understand the relationship between total phenolics with components of growth in mango, so that the knowledge thus gained would help in developing methodologies for tree size control in mango.

## MATERIAL AND METHODS

The experiment was conducted at the experimental field and laboratories of the Indian Institute of Horticultural Research, Hessarghatta, Bangalore. The experimental treatment comprised of seven varieties of mango. Of these, Kerala dwarf, Kodur hybrid and Amrapali were dwarf varieties, Alphonso and Janardhan pasand were medium vigorous varieties, while Chandrakaran and Gola were vigorous varieties. In each variety, a set of three trees were selected and this set of three trees were considered as replication and thus there were seven varieties replicated thrice and the design of experiment was randomized block design. The trees were 15 years old and were given uniform cultural treatments. On each tree, 20 healthy and uniform shoots from different sides of the tree

Table 1: Variation in growth parameters of tree vigour among different mango varieties.

| Varieties | Average shoot length (cm) | Average number of nodes | Mean internodal length (cm) | Mean tree | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Height (m) | Girth (m) | Spread (m) | Volume ($m^3$) | Mean leaf area ($cm^2$) |
| Kerala dwarf | 9.36 | 9.52 | 0.99 | 1.97 | 0.68 | 2.90 | 9.30 | 582.57 |
| Kodur hybrid | 19.98 | 20.82 | 0.96 | 2.75 | 0.62 | 4.13 | 25.76 | 632.46 |
| Amrapali | 18.08 | 15.43 | 1.30 | 2.30 | 0.60 | 3.15 | 12.00 | 1040.96 |
| Janardhana Pasand | 16.39 | 17.37 | 0.95 | 3.10 | 0.70 | 3.49 | 20.18 | 1121.93 |
| Alphonso | 25.47 | 20.95 | 1.22 | 4.37 | 1.03 | 7.07 | 119.05 | 1558.22 |
| Gola | 17.38 | 21.87 | 0.79 | 5.10 | 0.98 | 6.33 | 117.78 | 1004.13 |
| Chandrakaran | 22.85 | 19.36 | 1.19 | 5.60 | 1.25 | 6.48 | 125.84 | 983.55 |
| F test | * | * | * | * | * | * | * | * |
| CD at 5% | 6.10 | 4.56 | 0.27 | 1.15 | 0.28 | 1.49 | 64.25 | 173.34 |
| SEm ± | 1.98 | 4.56 | 0.27 | 0.37 | 0.09 | 0.49 | 20.85 | 56.25 |
| CV % | 18.54 | 14.31 | 14.11 | 17.90 | 18.70 | 17.52 | 58.80 | 9.85 |

were selected and which had fruited during March were tagged during November 1991. Shoot length, number of nodes per shoot, mean internodal length, leaf area, tree height, tree girth, tree spread and tree volume were recorded.

The total phenolic content in the bark of seven mango varieties were determined for different stages of tree growth namely before flowering (December, 1991), during flowering (January - February, 1992), during fruit growth (April, 1992), after harvest (June, 1992) and active shoot growth (September, 1992) by adopting calorimetric procedure described by Giebel (1970).

The total phenolic content was expressed in mg per cent (mg / 100g) on fresh weight basis. Phenolic content was correlated with various morphological characters by adopting methodology given by Singh and Choudhary (1976).

## RESULTS AND DISCUSSION

Data on various components of tree vigour (Table 1) showed significant variation among varieties with respect to shoot length, number of nodes per shoot, mean internodal length, tree height, tree girth, tree spread, tree volume and leaf area.

Correlation studies (Table 2) indicated that shoot length showed highly significant positive association with number of nodes per shoot leaf area, tree height, E - W spread, N - S spread and tree volume indicating that shoot length had a positive association with tree vigour. Shoot length was maximum in Alphonso followed by Chandrakaran and Kodur hybrid. However, minimum shoot length was found in Kerala dwarf. Shoot length had a positive association with tree vigour.

Number nodes per shoot showed highly significant positive relationship with tree height, E - W and N - S spread. It also showed significant positive correlation with tree volume. Maximum number of nodes per shoot was observed in Gola followed by Alphonso, Kodur hybrid, Chandrakaran and Janardhan pasand, while minimum was observed in Kerala dwarf. Number of nodes per shoot found to have significant influence on tree vigour.

Table 2 : Correlation coefficients between various morphological and biochemical characters as related to tree size and vigour in mango.

| | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X8 | X9 | X10 | X11 | X12 | X13 | X14 | X15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $X_1$ | 1.0000 | 0.5260* | 0.7171** | 0.7927** | 0.4874* | 0.8063** | - 0.2793 | - 0.2138 | - 0.1245 | - 0.1307 | - 4.006 | - 0.3535 | - 0.2031 | - 0.1890 | - 0.1873 |
| $X_2$ | | 1.0000 | 0.8100** | 0.7916** | 0.8475** | 0.8173** | 0.0271 | - 0.0832 | 0.1678 | 0.0952 | - 0.5317* | - 0.5243* | - 0.2929 | - 0.3061 | - 0.4095 |
| $X_3$ | | | 1.0000 | 0.8467** | 0.7696** | 0.8941** | - 0.2970 | - 0.1768 | - 0.1507 | - 0.1440 | - 0.6602** | - 0.6936** | - 0.4709* | - 0.4744 | - 0.5465* |
| $X_4$ | | | | 1.0000 | 0.7149** | 0.8605** | - 0.2962 | - 0.3154 | 0.0603 | - 0.0871 | - 0.7269 | - 0.6358** | - 0.5103* | - 0.5148* | - 0.5492* |
| $X_5$ | | | | | 1.0000 | 0.8162** | 0.1495 | 0.1231 | 0.1023 | 0.3644 | - 0.4021 | - 0.4722* | - 0.1348 | - 0.1416 | - 0.2763 |
| $X_6$ | | | | | | 1.0000 | - 0.1207 | - 0.0839 | 0.0020 | 0.0772 | - 0.5412* | - 0.5188* | - 0.2768 | - 0.2868 | - 0.3691 |
| $X_7$ | | | | | | | 1.0000 | 0.6355** | 0.4758* | 0.6617** | 0.6149** | 0.5173* | 0.7584** | 0.6588** | 0.6439** |
| $X_8$ | | | | | | | | 1.0000 | - 0.2035 | 0.3868 | 0.6120** | 0.3843 | 0.6202** | 0.6057** | 0.5364* |
| $X_9$ | | | | | | | | | 1.0000 | 0.3629 | - 0.0434 | 0.0799 | 0.1021 | 0.0145 | 0.0544 |
| $X_{10}$ | | | | | | | | | | 1.0000 | 0.4761* | 0.4592* | 0.6156** | 0.5699** | 0.5533** |
| $X_{11}$ | | | | | | | | | | | 1.0000 | 0.8836** | 0.8963** | 0.8849** | 0.9261** |
| $X_{12}$ | | | | | | | | | | | | 1.0000 | 0.8132** | 0.8517** | 0.8723** |
| $X_{13}$ | | | | | | | | | | | | | 1.0000 | 0.9694** | 0.9565** |
| $X_{14}$ | | | | | | | | | | | | | | 1.0000 | 0.9573** |
| $X_{15}$ | | | | | | | | | | | | | | | 1.0000 |

| | | | |
|---|---|---|---|
| * | Significant at $P = 0.05$ | $X_{10}$ | Leaf area (cm$^2$) |
| ** | Significant at $P = 0.01$ | $X_{11}$ | Tree height (m) |
| $X_1$ | Bark Phenol content (mg%) before flowering | $X_{12}$ | Tree girth (m) |
| $X_2$ | Phenol content in meristem (mg%) before flowering | $X_{13}$ | E - W spread (m) |
| $X_3$ | Bark Phenol content (mg%) during flowering | $X_{14}$ | N - S spread (m) |
| $X_4$ | Bark Phenol content (mg%) during fruit growth | $X_{15}$ | Tree volume (m) |
| $X_5$ | Bark Phenol content (mg%) after harvest | | |
| $X_6$ | Bark Phenol content (mg%) active shoot growth | | |
| $X_7$ | Shoot length (cm) | | |
| $X_8$ | Number of nodes per shoot | | |
| $X_9$ | Mean internodal length (cm) | | |

Mean internodal length did not show any significant association with leaf area, tree height, tree girth, E - W and N - S spread indicating that mean internodal length did not show any significant influence on tree vigour. Maximum mean internodal length was found in Amarapali followed by Alphonso and Chandrakaran, while minimum was found in Kerala dwarf. Similar observations were recorded in mango by Kurian (1989) and in apple by Zagaja and Faust (1983) wherein, it was observed that vigorous phenotype with shorter internodes and dwarfer phenotypes with longer internodes are very common. Leaf area expressed highly significant positive association wih N - S spread and tree volume and significant positive correlation with tree height and tree girth indicating that leaf area had sufficient influence on tree vigour. Maximum leaf area was found in Alphonso which differed significantly from the other varieties, minimum leaf area was observed in the dwarf cultivars namely Kerala dwarf and Kodur hybrid. Correlation studies indicated that the bark phenolic content with tree vigour during flowering and fruit growth was stronger compared to other stages. These results indicated that shoot length, number of nodes per shoot, leaf area, bark phenolic content during flowering and foot growth have given good negative correlation with tree vigour in mango. These observations could be used to predict the vigour in mango. These results are in line with the results obtained in mango by Kurian (1989), Babu *et al.* (1985) and Kurian *et al.* (1994). Studies are in progress to ascertain the existence of any correlation between phenolic content at the seedling stage with ultimate tree size.

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(Received on 27-05-2002 and revised on 25-08-2002)

*The Andhra Agric.* J. **50** (3&4) : 295 - 297, 2003

# Physico - Chemical Characteristics of Ber cv. Gola in Bikaner District of Rajasthan

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## ABSTRACT

The survey was conducted on 10 years old orchards of ber cv. Gola in Bikaner district indicated that physical attributes such as fruit weight, length and breadth, stone weight, pulp to stone ratio, total soluble solids, organic acids, ascorbic acid content, total sugars and reducing sugars varied significantly among the different orchards.

**Key words :** Physico - Chemical Characterstics, Gola

## METHODOLOGY

Studies were conducted on 10 year old healthy and vigorously growing trees of ber cv. Gola during the year 1999 - 2000 at its ripening stage i.e. January - February from the orchards of fruit growers in Bikaner district. The details of fruit orchards taken in the present study are given as under :

| S.No. | Name of fruit grower | Location |
|---|---|---|
| 1. | Dr. Jatan Lal Bafna | Garsisar 1 |
| 2. | Sh. Hakikat Rai Chhabra | Bikaner City 1 |
| 3. | Sh. Narendra Singh Tanwar | 488.5 RD 1 |
| 4. | Sh. Tejaram choudhary | 5 BSM 1 |
| 5. | Sh. Ramesh Prasad Atal | Nokha 1 |

For recording observations, 20 fresh fruits were randomly plucked from each experimental tree from all four directions and at each orchard, five trees were selected for assessing the physico-chemical characteristics of fruits. Observation were recorded for fruit weight, length, breadth, stone weight, pulp percentage, total soluble solids, total titratable acidity of juice, ascorbic acid, total sugars and reducing sugars. The total titratable acidity was determined by titration method (A.O.A.C., 1970). The ascorbic acid content of juice was determined by diluting the known volume of juice with 3 per cent Metaphosphoric acid and titrating it against 2,6-dichlorophenol - indophenol dye solution (A.O.A.C., 1970). Total sugar content was determined by using Anthrone reagent method (Dubois *et al.,* 1951) and reducing sugar content was measured by Nelson's Modification of 'Somogyis Method' using Arsenomolybdate reagent.

## RESULTS AND DISCUSSION

The data in orchard on the physico - chemical characteristics of ber fruit cv. Gola are presented in table - 1. It is eident from the data that the fruit weight varied significantly from each other in different orchards due to variations in soil texture, soil fertility status, quality of irrigation water, nutritional status of leaf and prevailing agro climatic conditions. The maximum average fruit weight (22.79 g per fruit), fruit size viz., maximum length of fruit (3.39cm) and maximum breadth of the frit (3.53cm) were measured at the orchard of 488.50 RD 1 as compared to minimum fruit weight and fruit size recorded at

Table 1 : Physico - chemical Characteristics of ber fruit cv. Gola

| Parameters / Locations | Garsisar 1 | Bikaner City 1 | 488.5 RD 1 | 5 BSM 1 | Nokha 2 | Pooled S.E.(±) | Pooled C.V. (%) |
|---|---|---|---|---|---|---|---|
| Weight per fruit (g) | 14.50 | 7.04 | 22.69 | 5.49 | 18.54 | 1.3581 | 49.77 |
| Length per fruit (cm) | 3.06 | 2.38 | 3.39 | 2.18 | 3.33 | 1.1031 | 17.96 |
| Breadth per fruit (cm) | 3.05 | 2.32 | 3.53 | 2.08 | 3.28 | 0.1156 | 20.24 |
| Stone weight (g) | 2.16 | 0.5 | 1.51 | 0.71 | 1.64 | 0.1187 | 44.30 |
| Pulp percentage | 859 | 88.54 | 92.40 | 84.96 | 90.71 | 0.6706 | 3.79 |
| Pulp to stone ratio | 6.70 | 10.70 | 14.96 | 7.84 | 11.28 | 0.6124 | 29.72 |
| TSS ($^0$Brix) | 15.36 | 11.50 | 14.72 | 13.83 | 15.93 | 0.3643 | 12.77 |
| Total Acidity (%) | 0.79 | 0.48 | 0.64 | 0.87 | 0.65 | 0.0353 | 25.63 |
| TSS / Acidity ratio | 19.44 | 23.95 | 23.00 | 15.89 | 24.50 | 0.9339 | 21.54 |
| Total Sugars (%) | 9.77 | 9.12 | 9.48 | 8.81 | 10.33 | 0.1151 | 6.05 |
| Reducing Sugars (%) | 4.95 | 4.13 | 4.49 | 3.26 | 4.15 | 0.1159 | 13.80 |
| Ascorbic Acid (mg/100 gm pulp) | 136.40 | 133.52 | 157.64 | 134.09 | 162.10 | 2.7622 | 9.54 |

the orchard of 5 BSM 1. It might be due to good amount of available nitrogen (30.07 mg kg$^{-1}$, DTPA extractable Fe (3.92 mg ka$^{-1}$), DTPA extractable Mn (2.22 mg kg$^{-1}$) in different soil depths, at as 488.5 RD 1, as compared to 5 BSM 1. Also, soil pH(8.39) and EC (0.01 dSm$^{-1}$) at 488.5 RD 1 were very less in obtaining better fruit weight and size at 488.5 RD 1. The present results are in close accordance with the findings of Chundawat (1990), Makhija *et al.* (1990), and Pareek and Vashishtha (1983).

Stone weight varied considerably from each other in different orchards. Maximum stone weight (2.16g) was recorded at the orchard of Garsisar 1, whereas minimum stone weight (0.65g) was recorded at the orchard of Bikaner City 1.

Pulp percentage ranged from maximum (92.40%) in fruits at 488.500 RD 1 to minimum (84.96%) in fruits at 5BSM 1 which are in accordnace with the findings of Meel *et al.* (1991). The maximum pulp to stone ratio i.e. 14.96 was found in the fruits at 488.5 RD 1. whereas minimum Pulp to stone ratio (6.70) was found in the fruits Garsisar 1. Similarly, Pareek and Vashishtha (1983) have reported pulp to stone ratio of 14.0 in cv. Gola.

The fruit quality in terms of total soluble solids (15.93$^0$ brix), total sugars (10.33 per cent) and ascorbic acid content (162.10 mg / 100 ml/pulp) was more at Nokha 2 as compared in Bikaner City 1 orchard which might be due to higher nutrients content in the leaves N (0.84%), P (0.51%), K(1.23%) at Nokha 2 orchard compared to Bikaner City 1 orchard and better quality of irrigation water at Nokha 2 (EC —> 0.48 dSm$^{-1}$, Na + —> 3.24 meq/litre, $Cl^-$ —> 2.5 meq./litre) as compared to Bikaner City 1 (EC —> 4.48 dSm$^{-1}$, $Na^+$ —> 27.23 meq/litre, $Cl^-$ —> 35 meq./litre), and better soil fertility status (EC —> 0.15 dSm$^{-1}$, organic carbon 0.26 per cent) at Nokha 2 as compared to (EC —> 0.68 dSm$^{-1}$) and organic carbon 0.16 per cent) at Bikaner City 1 orchard whic hare in close accordance with the findings of Daulta and Chauhan (1982). Maximum titratable acidity in fruit Pulp was (0.87%) obtained in ber fruits from 5 BSM 1 whereas minimum acidity percentage (0.48%) was recorded in the fruits at Bikaner City 1 . Similar findings were reported by Daulta and Chauhan (1982).

The total sugars percentage varied considerably from 8.81 to 10.33 per cent. It was maximum in the fruits at Nokha 2, whereas minimum (8.81%) was obtained in the fruits 5 BSM1.

The reducing sugar percentage also differed significantly from each other. Maximum reducing sugars (4.95%) was estimated in the fruits at Garsisar 1, whereas minimum reducing sugars (3.26%) was estimated in the fruits at 5 BSM 1. Almost similar content of total sugars and reducing sugars were reported by Gupta (1984) and Meel *et al.* (1991) in ber fruits.

There was great variation observed in the ascorbic acid content in the pulp of ber fruit samples. Maximum ascorbic acid content (162.10 mg / 100 g Pulp) was recorded in pulp of ber fruits at Nokha 2 orchard, whereas minimum ascorbic acid content (133.52 mg / 100 g pulp) was recorded in the pulp of ber fruits at Bikaner City 1 orchard.

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(Received on 15-05-2001 and revised on 16-07-2003)

*The Andhra Agric.* J. **50** (3&4) : 298 - 301, 2003

# Effect of Various Planting Material on Growth and Yield of Turmeric (*Curcuma longa*)

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## ABSTRACT

The result of the experiment conducted during 1995 - 96 and 1996 - 97 at the Regional Research and Techonology Transfer Station, G. Udayagiri on effect of eight different planting material on yield and economics of cultivation of turmeric revealed wide variation in yield, cost of cultivation, net profit and net profit per rupee invested due to difference in yield followed by Primary fingers and mother rhizome followed by mother rhizome 50% cut and primary fingers whereas the net profit was maximum with mother rhizome followed by primary fingers and mother rhizome 50% cut. But the net profit per rupee invested was maximum with primary fingers followed by mother rhizome 50% cut, secondary fingers and mother rhizome in decreasing order.

**Key words :** Planting material, Yield, Turmeric.

Turmeric is a leading cash crop for the tribal farmers of Orissa grown predominantly in the Kandhamal District of the State. Farmers are in practice of planting mother rhizome as the only seed material for turmeric. As a result, there was death of planting material during the planting season. An experiment was conducted at the Regional Research and Technology Transfer Station, G. Udayagiri during 1995 - 96 and 1996 - 97 to evaluate the performance of different planting material on yield and economics of cultivation of turmeric.

## MATERIAL AND METHODS

The experiment was conducted during the year 1995 - 96 and 1996 - 97 with eight different planting material viz Mother rhizome (40g), Primary finger (20g), Secondary finger (10g), Tertiary finger (5g), Mother rhizome 50% cut (20g), Primary finger 50% cut (2.5g) in a randomized block design with three replications. The soil of the experiment was clay loam with moderate fertility (O.C - .30, available p 18 - 205 kg/ha, K 20 - 405 kg /ha and $p^H$ 5.7). The crop variety 'Roma' was planted in flat beds in 2nd fortnight of May at a spacing of 30 x 10 cm and was fertilized with 0 - 30 - 30 NPK kg/ha as basal and mulched @ 50 t/ha after planting and top dressed with 15 kg N and 30 kg K at 45 days and 15 kg at 75 days of planting The weather condition was favourable in 1995 with total rainfall of 1525 mm distributed in 108 rainy days in contrast to drought year 1996 with scanty rainfall of 9088 mm distributed in 56 rainy days. The biometric observations were recorded at 150 days of planting (Mid growth) and yield attributes were recorded at harvest in the month of February in both the years.

## RESULTS AND DISCUSSION

The data on growth characters (Table 1) revealed significant difference in germination, plant height, length and breadth of leaves due to differences in planting material in both the years. The mother rhizome recorded significantly maximum germination percentage

Table 1 : Effect of various planting material on growth characters of turmeric (*Curcuma longa*)

| Treatments | Germination | | Plant height | | Leaves / Plant | | Aerial branches per plant | | Length of leaves (cm) | | Breadth of leaves (cm) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 1996 | 1995 | 1996 | 1995 | 1996 | 1995 | 1996 | 1995 | 1996 | 1995 | 1996 |
| Mother rhizome (40g) | 74.3 | 46.4 | 98.7 | 91.3 | 7.2 | 6.0 | 1.6 | 1.6 | 46.9 | 44.7 | 16.0 | 13.7 |
| Primary fingers (20g) | 67.3 | 39.0 | 79.1 | 76.5 | 7.1 | 6.0 | 1.5 | 1.5 | 39.6 | 41.1 | 14.8 | 12.7 |
| Secondary finger (10 g) | 39.7 | 21.0 | 63.3 | 61.1 | 6.4 | 5.8 | 1.5 | 1.2 | 34.0 | 31.7 | 11.7 | 10.7 |
| Tertiary finger (5 g) | 36.7 | 20.0 | 62.0 | 51.3 | 6.0 | 5.7 | 1.1 | 1.2 | 30.3 | 30.1 | 13.0 | 10.1 |
| Mother rhizome 50 % cut | 52.7 | 38.0 | 85.3 | 76.3 | 6.9 | 5.8 | 1.3 | 1.5 | 39.4 | 37.0 | 14.6 | 12.4 |
| Primary finger 50% cut | 24.3 | 15.0 | 67.1 | 57.1 | 6.9 | 5.7 | 1.3 | 1.3 | 36.0 | 31.1 | 12.6 | 10.5 |
| Secondary finger 50% cut | 23.7 | 7.0 | 60.3 | 55.7 | 6.4 | 5.5 | 1.3 | 1.2 | 30.2 | 29.5 | 10.7 | 10.5 |
| Tertiary finger 50% cut | 7.3 | 4.0 | 55.9 | 40.5 | 6.0 | 5.0 | 1.3 | 1.2 | 23.1 | 28.0 | 8.2 | 10.2 |
| C.D. (p=0.05) | 7.8 | 6.9 | 4.3 | 3.8 | NS | NS | NS | NS | 4.6 | 3.9 | 3.6 | 2.9 |

Table 2 : Effect of various planting material on yield attributes, yield and economics of cultivation of Turmeric (*Curcuma longa*)

| Treatments | Rhizome weight / plant | | Primary fingers / plant | | Secondery fingers / plant | | Fresh rhizome yield t/ha | | Cost of cultivation '000/ha | Profit Rs. '000/ha | Net Profit / rupee |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 1996 | 1995 | 1996 | 1995 | 1996 | 1995 | 1996 | (Average of two years) | | |
| Mother rhizome | 200.0 | 160.7 | 7.7 | 7.6 | 6.1 | 5.3 | 27.7 | 16.1 | 82.35 | 136.65 | 1.66 |
| Primary fingers | 195.8 | 125.4 | 6.9 | 6.9 | 5.3 | 4.1 | 21.4 | 13.7 | 49.05 | 126.95 | 2.59 |
| Secondary fingers | 130.4 | 120.4 | 6.5 | 6.5 | 4.5 | 3.9 | 12.0 | 6.8 | 32.35 | 61.65 | 1.91 |
| Tertiary fingers | 70.8 | 90.7 | 6.5 | 6.5 | 4.1 | 3.8 | 3.9 | 5.6 | 24.05 | 23.95 | 1.00 |
| Mother rhizome cut 50 % | 193.7 | 155.6 | 6.9 | 6.9 | 5.3 | 4.4 | 20.1 | 12.2 | 49.95 | 122.05 | 2.24 |
| Primary finger cut 50 % | 153.4 | 125.3 | 6.7 | 6.7 | 4.4 | 3.9 | 8.0 | 7.9 | 33.35 | 46.65 | 1.40 |
| Secondary finger cut 50 % | 93.6 | 115.7 | 6.5 | 6.5 | 4.3 | 3.8 | 3.5 | 5.5 | 24.45 | 20.55 | 0.84 |
| Tertiary finger cut 50 % | 50.8 | 78.8 | 5.9 | 5.9 | 3.4 | 3.0 | 0.6 | 2.8 | 20.25 | -3.25 | |
| C.D. (p=0.05) | 10.8 | 8.9 | NS | NS | NS | NS | 4.3 | 3.9 | - | | |

Cost of Urea Rs. 74/-, Ssp 304/- and MOP 360/- per quintal, Labour Rs. 30/day, Cost of raw turmeric Rs. 1000/q.

(74.3/46.4), plant height (98.7/91.3 cm) length of leaves (46.9/44.7 cm) and breadth of leaf 16.0/13.7 cm) followed by primary finger and mother rhizome cut in decreasing order. Planting of secondary fingers. Tertiary fingers either whole or cut and primary fingers cut resulted in significant reduction in growth characters.

The higher growth characters in former case was due to the higher seed size of the planting material. This was in agreement with the findings of Balashanmugam and Vanangamudi (1988).

The data on yield attributes and yield of turmeric (Table 2) revealed no significant differences in number of primary fingers and secondary fingers due to difference in planting material. However, mother rhizome recorded significantly maximum rhizome weight per plant (200/165.7g) followed by primary fingers (195.8/125.4g) and mother rhizome cut (193.7/195.6g) in both the years 1995 - 1996 in decreasing order. Such difference in rhizome weight was due to difference in growth characters among the planting material (Table 1). The mother rhizome also produced maximum fresh rhizome yield (27.7/16.1) followed by primary fingers (21.4/13.7) and mother rhizome cut (20.1/12.2 t/ha) due to higher crop stand and rhizome weight/plant as compared to other planting material. This was in agreement with the findings of Balashanmugam and Vanangamudi (1998) and Singh *et al.* (1988).

## Economics

The cost of cultivation was observed to be the highest in planting mother rhizome followed by mother rhizome 50% cut and primary fingers, in decreasng order and was lowest with the tertiary finger cut due to higher requirement of seed material in the former cases. Profit was maximum with mother rhizome (Rs. 136650) followed by primary finger and mother rhizome

50% cut due to higher production than other treatments. But the net profit per rupee invested was maximum with planting of primary finger (2.6) followed by mother rhizome 50% cut (2.24), secondary finger (1.91) and mother rhizome (1.66) in decreasing order. Such low net profit per rupee invested in mother rhizome was due to high cost of production.

## CONCLUSION

Although planting of mother rhizome produced maximum net profit, but as it requires high cost investment can be only recommended for rich farmers. Primary fingers and mother rhizome 50% cut can be recommended as alternate planting material in absence of mother rhizome and also for small, marginal and resouce poor farmers.

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(Received on 26-06-2000 and revised on 07-11-2003)

*The Andhra Agric.* J. **50** (3&4) : 302 - 305, 2003

# Character Association and Path Analysis in Okra (*Abelmoschus esculentus* (L.) Moench)

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## ABSTRACT

An effective breeding programme for development of good quality and high yielding varieties requires preliminary information on the nature and magnitude of genetic variation in the available material and association of character with yield and among themselves. The study of correlation alone does not provide an exact picture of relative importance of direct and indirect influence of each of the component towards the desired effect and sometimes leads to misinterpretation of the obtained results when more variables are included in the study and indirect association becomes more complex. In such a situation, the path coefficient analysis provides an effective means of finding direct and indirect causes of association. The estimation of the direct and indirect effect of yield components on yield will help in the simulataneous improvement of many characters in directed crop evolution. This technique has been used to a very limited extent by vegetable breeders. The present investigation was therefore, designed to furnish the information on nature of association among different yield traits and to work out suitable selection criteria for predicting yield in okra.

**Key words :** Character Association, Path Analysis, Okra.

## MATERIAL AND METHODS

The study was conducted at Vegetable Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during the summer (E1) and *kharif* (E2) season of 1994 on 40 F1's of okra. The experiment was laid out in a randomized block design with three replications. The recommended package of practices was followed to raise a good crop. Data were recorded on ten competitive tagged plants of each hybrid for days to first flower appearance, node at which first flower appears, plant height (cm.), number of branches / plant, number of pods / plant, length of pod (cm), girth of pod (cm.) and total pod yield/plant (g). The genotypic, phenotopic and error variances were used to calculate the genotypic, phenotypic and environmental correlation coefficients as suggested by Johnson *et al.* (1955). The genotypic correlation coefficients were used to find out the direct and indirect effects of the component characters on pod yield, according to Dewey and Lu (1959).

## RESULTS AND DISCUSSION

Analysis of variance showed highly significant differences for most of the characters under study, thereby, suggesting the presence of variability among the genotypes assessed. The phenotypic and environmental correlation coefficients for different pairs of characters are given in Table 1. In general, the genotypic correlations were higher in magnitude than the phenotypic ones, which gives an idea that there is inherent association between various characters. This is an agreement with the earlier report by Johnson *et al.* (1955). This may confirm the considerable role of environment in

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Table 1 : Phenotypic (P), Genotypic (G) and environmental (E) correlation coefficients among characters in okra.

| Characters | | Node at which first flower | | Plant height | | Number of pods/plant | | Length of pod | | Girth of pod | | Total pod yield / plant | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $E_1$ | $E_2$ | $E_1$ | $E_2$ | $E_1$ | $E_2$ | $E_1$ | $E_2$ | $E_1$ | $E_2$ | $E_1$ | $E_2$ |
| Days to first | P | 0.177 | 0.256 | 0.004 | 0.024 | 0.195 | -0.045 | -0.231 | -0.086 | 0.168 | -0.241 | -0.220 | -0.078 |
| Flower | G | 0.713 ** | 0.422** | -0.017 | 0.038 | -0.142 | -0.140 | -0.409** | -0.172 | 0.397* | -0.445** | -0.344* | -0.132 |
| appearance | E | -0.006 | 0.020 | 0.058 | 0.011 | -0.250 | 0.198 | -0.122 | 0.099 | 0.084 | -0.073 | -0.054 | -0.049 |
| Node at which | P | | | 0.079 | 0.356* | 0.169 | 0.075 | -0.321* | 0.289 | 0.293 | -0.179 | -0.214 | -0.032 |
| first flower | G | | | 0.273 | 0.371** | -0.091 | 0.076 | -0.596** | 0.323* | 0.091 | -0.251 | -0.318* | -0.034 |
| appears | E | | | -0.036 | 0.98 | -0.234 | -0.064 | -0.244 | -0.162 | 0.270 | -0.023 | -0.282 | 0.044 |
| Plant | P | | | | | 0.439** | 0.486** | 0.159 | 0.652** | 0.094 | 0.117 | 0.292 | 0.496 |
| height | G | | | | | 0.626** | 0.504** | 0.234 | 0.677** | 0.471** | 0.182 | 0.336* | 0.501** |
| | E | | | | | -0.029 | 0.021 | 0.106 | -0.105 | 0.022 | -0.211 | -0.020 | 0.010 |
| Number of | P | | | | | | | 0.275 | 0.456** | -0.159 | 0.315 | 0.748** | 0.842** |
| pods / | G | | | | | | | 0.538** | 0.478** | 0.790** | 0.418** | 0.981** | 0.868** |
| plant | E | | | | | | | 0.065 | 0.105 | -0.275 | 0.123 | 0.256 | 0.243 |
| Length of | P | | | | | | | | | 0.355* | 0.327* | 0.432** | 0.579** |
| pod | G | | | | | | | | | -0.195 | 0.466** | 0.548** | 0.594** |
| | E | | | | | | | | | -0.409** | -0.010 | 0.435** | 0.221 |
| Girth of | P | | | | | | | | | | | -0.413** | 0.453** |
| pod | G | | | | | | | | | | | -0.438** | 0.623** |
| | E | | | | | | | | | | | -0.978** | 0.029 |

*,** Significant at P = 0.05 and P = 0.01 respectively.

Table 2 : Path coefficient analysis showing direct (underlined figures) and indirect effects of six characters on pod yield in okra.

| Characters | Days to first flower appearance | | Node at which first flower appears | | Plant height | | No. of pods / plant | | Length of pod | | Girth of pod | | Genotypic correlation with pod yield / plant | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $E_1$ | $E_2$ | $E_1$ | $E_2$ | $E_1$ | $E_2$ | $E_1$ | $E_2$ | $E_1$ | $E_2$ | $E_1$ | $E_2$ | $E_1$ | $E_2$ |
| Days to first flower apperance | -0.317 | 0.191 | -0.005 | -0.072 | 0.009 | 0.001 | -0.187 | -0.094 | 0.062 | -0.038 | 0.095 | -0.127 | -0.344* | -0.132 |
| Node at which first flower appears | -0.226 | 0.081 | -0.007 | -0.170 | -0.122 | 0.008 | -0.120 | 0.051 | 0.090 | 0.070 | 0.067 | -0071 | -0.318* | -0.034 |
| Plant height | 0.006 | 0.007 | -0.002 | -0.063 | -0.513 | 0.023 | 0.827 | 0.338 | -0.035 | 0.148 | 0.053 | 0.052 | 0.336 | 0.501 |
| No. of pods/plant | 0.045 | 0.027 | 0.001 | -0.013 | -0.321 | 0.012 | 1.321 | 0.071 | -0.081 | 0.104 | 0.017 | 0.119 | 0.981 | 0.868 |
| Length of pod | 0.130 | -0.033 | 0.004 | -0.055 | -0.120 | 0.015 | 0.710 | 0.321 | -0.151 | 0.218 | -0.026 | 0.133 | 0.548 | 0.594 |
| Girth of pod | -1.395 | -0.085 | -0.020 | 0.043 | -1.267 | 0.004 | 1.043 | 0.280 | 0.180 | 0.101 | 0.022 | 0.285 | -0.438 | 0.628 |

Residual effect = -0.121 ($E_1$), 0.118 ($E_2$).

modifying the expression of the genotypes (Nandpuri *et al.*, 1970). Positive and significant association of plant height, number of pods/plant, length of pod and girth of pod with yield suggested that effective improvement in okra through these components could be achieved by simple selection. Similar results were also reported by Elangovan *et al.* (1980) and Mishra and Singh (1985).

The environmental correlations which are not strictly reflecting the correlation of environmental deviations, but the correlation of environmental deviations together with non-additive genetic deviations revealed that pod yield/plant had high and positive correlations with length of pod and number of pods/plant.

Yield is a very complex quantitative character and was greatly influenced by its various components, directly as well as indirectly via other characters. For an effective recommendation of selection indices, these effects and their interrelationship must need path analysis. Out of six pod yield components, the number of pods/plant had maximum direct effect (1.321) on positive direction (Table 2). The direct effects of the remaining characters were quite low. The strong positive association of number of pods/plant with yield was due to its direct contribution which was also the highest in magnitude, thereby indicating a true correlation and could be taken as a major component for the improvement of yield. The indirect effect of number of pods/plant via all other characters studied was positive except plant height. The direct effect was maximum in negative direction for the character, plant height (10.513) and its indirect effects were positive for days to first flower appearance, number of pods/plant and girth of pod. These findings are in agreement with the findings of Ajmal *et al.* (1979), Mishra and Singh (1985) and Vijay and Manohar (1990).

It is evident from the above discussion that the characters like, number of pods/plant, length of pod, girth of pod and days to first flower appearance should be considered essential while selectioning high pod yield because they have high genotypic value and maximum direct or indirect effect towards pod yield. The residual effect was quite low indicating that characters other than studied have very little effect.

Correlation and path analysis studies were conducted in 40 $F_1$S of okra to assess the association between pairs of characters and their contribution towards yield. All the characters exhibited high correlation values with yield at all the three levels. In general, the genotypic correlations were higher in magnitude than the phenotypic levels. Positive and significant association of plant height, number of pods/plant, length of pod and girth of pod with yield were recorded. Path analysis suggested that for selecting high yielding okra genotypes, stress should be given on number of pods/plant, length and girth of pod and days to first flower appearance.

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(Received on 11-01-2000 and revised on 07-11-2003)

*The Andhra Agric.* J. **50** (3&4) : 306 - 310, 2003

# Heterosis and Correlation Studies in Pumpkin (*Cucurbita moschata Duch. ex. poir*)

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## ABSTRACT

Ten F1 crosses of pumpkin in a 5 x 5 diallel set involving five parents viz., CM 45, CM 14, CM 12, TPT 2 and CM 64 (excluding reciprocals) were evaluated to study heterosis for thirteen characters. Appreciable heterosis was recorded over better parental lines for all the characters. The three F1 hybrids namely CM 45 x TPT 2, CM 45 xx CM 12 and CM 45 x CM 14 showed 132.86, 89.93 and 87.09 per cent heterobeltiosis respectively for yield per vine. Correlation studies revealed that yield per vine was significantly and positively correlated with number of fruits per vine and fruit weight. This increase in yield might be attributed to higher number of fruits per vine, fruit weight, fruit diameter, fruit length and fruit flesh thickness. Fruit weight displays negative and significant correlation with number of fruits per vine. Hence yield improvement in pumpkin can be achieved by selection of number of fruits per vine and fruit weight.

**Key words :** Heterosis, Correlation, Pumpkin.

Pumpkin is a cross pollinated crop and this has resulted in a large variation in several quantitative and qualitative characters. Hence it provides ample scope for utilisation of heterosis. Before initiating effective selection programme aimed at genetic improvement in yield, it is necessary to know the importance of association of various components with yield. Correlation is the important biometric tool which measures the mutual relationship and determines the yield components. The present investigation was carried out through a 5 x 5 diallel to study the extent of heterosis and to determine the nature and degree of association among the characters.

## MATERIAL AND METHODS

The present study was undertaken on a diallel set of $F_1$ hybrids (excluding reciprocals) involving five diverse genotypes as parents. They were CM 45, CM 14, CM 12, CM 64 (seeds were obtained from NBPGR, New Delhi) and TPT 2 (local variety). Ten $F_1$ hybrids along with their five parents were grown in a randomised block design with three replications at Horticultural Garden, S.V. Agricultural College, Tirupati during *kharif* season of 2000 - 2001. The rows were spaced 2.5 m apart and intra row spacing was 1.5 m. Two active seedlings were maintained per pit. Observations were recorded on thirteen characters. Heterosis and heterobeltosis were measured as deviation from the midparental value and better parental value respectively in the favourable direction.

## RESULTS AND DISCUSSION

Results of the characters which are studied for heterosis are presented in Table 1.

The maximum percentage of heterosis over their respective better parent was recorded for different characters included CM 12 x TPT 2 for vine length (42.52), CM 12 x CM 64 for number of node at which first male flower appeared (-53.53) and number of seeds per fruit (159.79), CM 14 x CM 64 for days to first female

Table 1 : Heterosis (H) and Heterobeltiosis (HB) for certain characters in 10 $F_1$ progenies

| Hybrids | Vine length (m) | | Number of node at which first female flower appeared | | Number of node at which first male flower appeared | | Days to first female flowering | | Days to first male flowering | | Number of fruits per vine | | Fruit weight (kg) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H | HB | H | HB | H | HB | H | HB | H | HB | H | HB | H | HB |
| **CM 45 X** | | | | | | | | | | | | | | |
| CM 14 | -24.19** | -31.02** | -2.81* | -13.57** | 41.67** | 30.77** | -13.11** | -17.54** | -4.26** | -12.60** | 26.67* | 11.76 | 52.65** | 40.35** |
| CM 12 | 39.55** | 15.30** | -6.72** | -20.71** | 6.67 | -7.69 | 9.23** | -4.75** | 9.80** | 5.52** | 30.00** | 13.04 | 103.02** | 67.98** |
| TPT 2 | 52.30** | 30.12** | -27.88** | -30.71** | -11.54 | -11.54 | -11.48** | -13.38** | -3.59** | -7.21** | 27.27* | 23.53 | 84.76** | 77.40** |
| CM 64 | 25.01** | 23.83** | -10.59** | -18.57** | 14.29* | 6.67 | -1.01* | -9.76** | 11.69** | 11.69** | 10.53 | 0.00 | 27.00* | 11.22** |
| **CM 14 X** | | | | | | | | | | | | | | |
| CM 12 | 23.31** | -5.37** | 26.57** | 20.18** | 7.32 | 0.00** | 34.09** | 11.85** | -4.11** | -15.55** | 77.78** | 39.13** | 28.94** | 14.79** |
| TPT 2 | -20.87** | -37.45** | 1.68 | -6.20** | 79.17** | 65.38** | -18.83** | -21.33** | -3.97** | -9.12** | 37.93** | 25.00 | 10.81** | 5.91** |
| CM 64 | -48.80** | -53.81** | 32.14** | 28.70** | 23.08** | 6.67 | -11.44** | -22.99** | 0.15 | -8.58** | 35.29** | 9.52 | 17.19** | 11.09** |
| **CM 12 X** | | | | | | | | | | | | | | |
| TPT 2 | 48.42** | 42.52** | 6.61** | -6.20** | 11.11 | -3.85 | 7.08** | -8.33** | 8.91** | 0.90 | 12.82 | -4.35 | 14.72** | -1.84** |
| CM 64 | 41.09** | 17.46** | -4.23** | -11.30** | -42.86** | -53.33** | 42.76** | 35.90** | 0.34 | -3.57** | 27.27* | 21.74* | 15.18** | 7.76** |
| **TPT 2 X** | | | | | | | | | | | | | | |
| CM 64 | 55.29** | 33.74** | -15.57** | -20.16** | 35.71** | 26.67** | -6.50** | -16.41** | -2.34** | -6.01** | 8.1 | -4.76 | 9.01** | -0.99* |
| **CD at** | | | | | | | | | | | | | | |
| P = 0.05 | 0.14 | 0.16 | 0.49 | 0.57 | 0.51 | 0.59 | 0.45 | 0.52 | 0.56 | 0.64 | 0.60 | 0.70 | 0.02 | 0.02 |
| P 0.01 | 0.19 | 0.22 | 0.67 | 0.77 | 0.70 | 0.80 | 0.61 | 0.71 | 0.75 | 0.87 | 0.82 | 0.95 | 0.03 | 0.03 |

Table 1 Continued

| Hybrids | Fruit diameter (m) | | Fruit length (cm) | | Fruit flesh thickness (cm) | | Yield per vine (kg) | | Number of seeds per fruit | | Thousand seed weight (g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H | HB | H | HB | H | HB | H | HB | H | HB | H | HB |
| **CM 45 X** | | | | | | | | | | | | |
| CM 14 | 20.14** | 15.75** | -11.76** | -15.65** | 30.05** | 29.35** | 95.77** | 87.09** | 31.63** | -8.18** | 23.01** | 16.12** |
| CM 12 | 29.65** | 10.13** | 11.97** | 11.00** | 41.67** | 36.00** | 155.94** | 89.93** | 181.36** | 135.93** | -0.00 | 12.50** |
| TPT 2 | 32.44** | 24.15** | 80.67** | 72.92** | 68.36** | 61.96** | 135.43** | 132.86** | 40.63** | 9.36** | 25.59** | 10.08** |
| CM 64 | -8.24** | -18.84** | 46.88** | 21.33** | 36.05** | 27.17** | 38.27** | 11.20 | 83.02** | 78.36** | 5.26** | -0.73 |
| **CM 14 X** | | | | | | | | | | | | |
| CM 12 | 0.78 | -11.62** | 2.03* | -1.71* | 17.28** | 12.00** | 121.66** | 59.73** | 57.74** | 24.91** | 9.47** | -8.81** |
| TPT 2 | 23.81** | 12.11** | -2.40** | -10.51** | 28.41** | 24.18** | 53.57** | 45.23* | -4.11** | -71.94** | 17.39** | -2.06 |
| CM 64 | 2.56** | -6.19** | 22.53** | 5.07** | 9.94** | 3.30 | 56.53** | 21.67 | 60.13** | 13.40** | 13.82** | 1.69 |
| **CM 12 X** | | | | | | | | | | | | |
| TPT 2 | 3.80** | -16.38** | 34.44** | 27.70** | -16.76** | -23.00** | 25.54* | -6.16 | 46.00** | 32.87** | -2.87* | -3.07* |
| CM 64 | -20.76** | -24.38** | 23.87** | 2.97** | 17.78** | 6.00* | 46.15** | 31.22** | 203.26** | 159.79** | -14.54** | -21.11** |
| **TPT 2 X** | | | | | | | | | | | | |
| CM 64 | 3.62** | -13.34** | 12.10** | -10.49** | 0.61 | -2.35 | 16.19 | -5.76 | 136.91** | 87.77** | 6.12** | -1.85 |
| **CD at** | | | | | | | | | | | | |
| P = 0.05 | 0.43 | 0.50 | 0.20 | 0.23 | 0.17 | 0.19 | 1.85 | 2.14 | 3.30 | 3.81 | 3.65 | 4.21 |
| P 0.01 | 0.58 | 0.67 | 0.27 | 0.31 | 0.23 | 0.26 | 2.50 | 2.89 | 4.46 | 5.15 | 4.92 | 5.69 |

* Significant at P = 0.05

** Significant at P = 0.01

Table 2 : Phenotypic ($r_p$) and Genotypic ($r_g$) correlation co-efficients among certain characters in a 5 x 5 diallel of pumpkin.

| Character | | Number of first female flower node | Number of first male flowering node | Days to first female flowering | Days to first male flowering | Number of fruits per vine | Fruit weight (kg) | Fruit diameter (cm) | Fruit length (cm) | Fruit flesh thickness (cm) | Number of seeds per fruit | Thousand seed weight (g) | Yield per vine (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vine length (m) | $r_p$ | -0.4970** | -0.1894 | 0.3755** | 0.0350 | 0.1088 | 0.2845 | -0.0466 | 0.3950** | 0.2847 | 0.3324* | -0.1516 | 0.2412 |
| | $r_g$ | -0.5022** | -0.1948 | 0.3758* | 0.0357 | 0.1212 | 0.2848 | -0.0471 | 0.3954** | 0.2893 | 0.3328* | -0.1526 | 0.2493 |
| Number of first female | $r_p$ | | 0.2703 | 0.2017 | 0.3090* | -0.0370 | -0.3208* | -0.2806 | -0.2314 | -0.3000* | -0.1519 | -0.2428 | -0.1862 |
| flowering node | $r_g$ | | 0.2824 | 0.2035 | 0.3146* | -0.0443 | -0.3246* | -0.2826 | -0.2334 | -0.3099* | -0.1538 | -0.2500 | -0.1965 |
| Number of first male | $r_p$ | | | -0.4376** | 0.3354* | -0.2772 | -0.2684 | -0.0745 | -0.0409 | -0.0858 | -0.1505 | 0.1745 | -0.3337* |
| flowering node | $r_g$ | | | -0.4563** | 0.3372* | -0.3583* | -0.2810 | -0.0786 | -0.0460 | -0.0909 | -0.1578 | 0.1918 | -0.3754* |
| Days to first female | $r_p$ | | | | 0.2243 | 0.2117 | 0.0170 | -0.3622* | -0.2033 | 0.0190 | 0.4306** | -0.3806** | 0.1806 |
| flowering | $r_g$ | | | | 0.2268 | 0.2541 | 0.0169 | -0.3638* | -0.2043 | 0.0177 | 0.4312** | -0.3850** | 0.1940 |
| Days to first male | $r_p$ | | | | | -0.4185** | -0.1898 | -0.2934 | -0.0327 | -0.1057 | 0.0932 | -0.3591* | -0.3110* |
| flowering | $r_g$ | | | | | -0.5111** | -0.1911 | -0.2994* | -0.0335 | -0.1057 | 0.0934 | -0.3572* | -0.3391* |
| Number of fruits | $r_p$ | | | | | | -0.5653** | 0.4637** | 0.2019 | 0.2908 | 0.4865** | 0.1615 | 0.8611** |
| per vine | $r_g$ | | | | | | -0.6477** | 0.5219** | 0.2333 | 0.3340* | 0.5560** | 0.1977 | 0.8715** |
| Fruit weight (kg) | $r_p$ | | | | | | | 0.7572** | 0.1736 | 0.7208** | 0.5104** | 0.2149 | 0.8966** |
| | $r_g$ | | | | | | | 0.7610** | 0.1736 | 0.7308** | 0.5106** | 0.2174 | 0.9307** |
| Fruit diameter (cm) | $r_p$ | | | | | | | | -0.0387 | 0.4178** | 0.1824 | 0.2157 | 0.6854** |
| | $r_g$ | | | | | | | | -0.0387 | 0.4264** | 0.1833 | 0.2190 | 0.7097** |
| Fruit length (cm) | $r_p$ | | | | | | | | | 0.1695 | 0.1226 | 0.0277 | 0.1602 |
| | $r_g$ | | | | | | | | | 0.1705 | 0.1226 | 0.0295 | 0.1679 |
| Fruit flesh thickness | $r_p$ | | | | | | | | | | 0.1969 | 0.2497 | 0.5741** |
| | $r_g$ | | | | | | | | | | 0.2001 | 0.2505 | 0.6047** |
| Number of seeds | $r_p$ | | | | | | | | | | | -0.0722 | 0.5761** |
| per fruit | $r_g$ | | | | | | | | | | | -0.0729 | 0.5973** |
| Thousand seed | $r_p$ | | | | | | | | | | | | 0.1704 |
| weight | $r_g$ | | | | | | | | | | | | 0.1844 |

* Significant at P = 0.05
** Significant at P = 0.01

flowering (-22.99), CM 14 x CM 12 for days to first female flowering (-15.55) and number of fruits per vine (39.13), CM 45 x TPT 2 for number of node at which first female flower appeared (-30.71), fruit weight (77.40), fruit diameter (24.15), fruit length (72.92), fruit flesh thickness (61.96) and yield per vine (132.86) and CM 45 x CM 14 (16.12) for thousand seed weight. The F1 cross CM 45 x CM 64 for number of fruits per vine and CM 45 x CM 12 for thousand seed weight showed zero per cent heterobeltosis and heterosis indicating that the performance of these hybrids was almost on par with their better parent and mid parent respectively.

The first top three $F_1$ hybrids CM 45 x CM 12, CM 45 x TPT 2 and CM 45 x CM 14 showed 132.86, 89.93 and 87.09 per cent heterosis for yield per vine over their respective better parents respectively. This might be due to higher number of fruits per vine, higher fruit weight, fruit diameter, fruit length and fruit flesh thickness. Similar findings were reported in pumpkin by Sirohi *et al.* (1985) for number of fruits per vine, Sirohi (1994) for fruit weight, Doijode *et al.* (1982) and Sirohi (1994) for fruit diameter and fruit length and Sirohi *et al.* (1985) and Mohanty and Mishra (1999) for fruit flesh thickness.

These results suggested that the F1 hybrid CM 45 x TPT 2 which gave 132.86 per cent higher yield over better parent can be taken up for commercial cultivation.

In most of characters, the magnitude of genotypic correlation co-efficient was found to be higher than the phenotypic correlation co-efficient indicating a strong inherent association among various characters (Table 2). Yield per vine had positive and significant correlation with fruit weight followed by number of fruits per vine, fruit diameter, fruit flesh thickness and number of seeds per fruit. Hence, the increase in yield per vine can be achieved due to increase in fruit weight and number of fruits per vine. These results are in concurrence with the findings of Rana *et al.* (1986) for fruit weight, fruit flesh thickness and number of fruits per vine. Negative and significant association with yield per vine was exhibited by number of frist male flowering node and days to first male flowering. Fruit weight had positive and significant correlation with fruit diameter, fruit flesh thickness and number of seeds per vine indicating any selection aimed for increase in fruit diameter, fruit length and fruit flesh thickness would increase the fruit weight which inturn increases the fruit yield per vine. The character number of fruits per vine exhibited negative and significant correlation with fruit weight. This indicated that the increase in number of fruits per vine would decrease fruit weight. This might be due to competition between these two divergent forces and resulted in significant negative correlation. These results are in concurrence with the fndings of Lal and Singh (1997).

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(Received on 27-12-2001 and revised on 23-08-2003)

*The Andhra Agric.* J. **50** (3&4) : 311 - 315, 2003

# Comparison of Darcy - Weisbach (DW) and Hazen - Williams Equations for Prediction of Frictional Loss in Trickle Pipes

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## ABSTRACT

Accurate prediction of frictional loss in trickle pipes is an important aspect in the successful design of trickle irrigation systems. Traditionally Hazen - Williams (HW) equation is used due to its simplicity and ease in using the equation. Darcy - Weisbach (DW) equation though little complicated provides better estimates of frictional losses at all times. This equation has provision for accounting for change of frictional factor, which is due to change in viscosity and temperature of water. Predictions made at different temperatures indicated that the DW equation predicted the frictional losses more accurately than the HW equation. Due to invent of computer programs and software the use of DW equation gained momentum and researchers started using this equation for its veracity.

**Key words :** Darcy - Weisbach, Hazen - Williams Equations, Peridiction, Frictional Loss.

Uniform application of water is necessary criterion in the design of trickle irrigation system. Minimising pressure variation with in the subunit attains higher uniformity of water application. Generally the pressure variation in the subunit is limited to 20% so that the discharge variation will be less than 10%. Hence accurate estimation of frictional losses in the trickle pipes is an important issue.

Because of its simplicity, the Hazen - Williams (HW) equation (Bezdek and Solomon, 1978) is widely used in the irrigation industry to calculate friction losses in irrigation pipes. This use has been extended to include plastic irrigation lateral lines, even though such lines generally have smaller diameters and lower flow rates than are usually encountered in other irrigation systems.Regarding trickle laterals, Keller and Karmeli (1974) noted that the Hazen - Williams equation with a roughness coefficient of C as 150 is normally used for plastic pipe. Howell and Hiler (1974) advance an argument for using C = 130. Bezdek and Solomon (1978) indicate that no matter what value of C is chosen for use in the Hazen - Williams equation, the Darcy-Weisbach (DW) equation is a more acurate basis for calculating head losses in the small diameter plastic tubing used for trickle laterals.

Bernuth and Wilson (1989) confirmed form their analysis of data collected on three small diameter plastic pipe sections that the Blasius equation is a very accurate predictor of the Darcy - Weisbach (D-W) friction factor when Reynolds numbers are less than 100,000. The two equations can be readily combined into one that is dimensionally homogeneous and contains a viscosity term. It is conveniently written in flow rate, pipe diameter, and pipe length terms. Keller and Bliesner (1990) gave the formulae and tables to calculate the head loss due to friction in pipeline. The Hazen - Williams equation was used for aluminium pipe of sprinkler irrigation. The Darcy - Weisbach equation was used for

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polyethylene hose of trickle irrigation and IPS - PVC thermoplastic pipe of sprinkler and trickle irrigation. They also quoted two other equations, which were used for smooth plastic pipes of smaller diameter (less than 125 mm) and larger diameter (greater than 125 mm).

Watters and Keller (1978) and von Bernuth and Wilson (1989) have shown that the Blasius equation works well for small diameter plastic pipe when Reynolds number is less than 100,000. Design limitations on velocity in irrigation pipelines (1.5 m/sec) will limit Reynolds numbers to 100,000 for pipe 64 mm or smaller. When the velocity is at the design limit, the error for 102 mm pipe with Reynolds number of 157,400 would be - 3.6% and for 152 mm pipe with Reynolds number of 236,100 the error would be - 5.6%. Assuming that the design velocity limits are met the Blasius equation will yield reasonably accurate estimation of the friction factor for pipe smaller than 80 mm. The 100,000 Reynolds number limits should be adhered to for pipes larger than 80 mm.

Many practicing engineers hesitate to use the D-W equation and prefer simpler empirical equations not requiring calculation of the Reynolds number and reference to a table of viscosity values to other equations. However, failure to correct for viscosity differences can lead to significant error. For example, a 20°C change in temperature would lead to 11% error in friction loss if viscosity changes were ignored. In spite of the accuracy disadvantages of empirical equations, engineers continue to use them. In the past the incomplete knowledge of the flow velocity profile encouraged the empirical analysis of the friction factor measurements. Empirical relationships like, Balsius, Hazen - Williams and Manning's equations (Kamand, 1988; von Bernuth and Wilson, 1989) were developed. Some of these relationships characterized by a simple Mathematical form, neglect the variability of the friction factor with the flow conditions and as a result they only allow accurate head loss estimation for given ranges of velocity and pipe diameter.

L = length of pipe, m

Q = flow rate, l $h^{-1}$

D = internal diameter of pipe, mm

C = a constant having different values for different pipe material and sizes (Hazen - Williams constant)

For PVC pipes the following values of C are generally used

$C = 130$ ($D < 17$ mm)

$C = 140$ ($17 \geq D < 21$ mm)

$C = 150$ ($D > 21$ mm).

**Darcy - Weisbach Equation**

Research workers have found Darcy - Weisbach formula more accurate, theoretically sound dimensionally correct among all other equations. The frictional head loss due to Darcy - Weisbach equation depends on the flow regime in the pipeline, which is characterised by the Reynolds number. The Darcy - Weisbach equation for frictional head loss is given by

$$H_l = \frac{f L V^2}{2 g D}$$

where, D = internal diameter of pipe, m

V = velocity of flow, m $s^{-1}$

g = acceleration due to gravity, m $s^{-2}$

f = Darcy's frictional factor

$H_l$ and L are equal to $\triangle H$ and $\triangle L$ as defined earlier

Considering discharge in place of velocity and taking $g = 9.81\ m\ s^{-2}$ in the above Eq. 4, we get,

$$H_f = 6.3755\ f\ L\ Q^2\ D^{-5}$$

where, $H_f$, L, Q and D are as defined in Eq. 3.

The friction loss coefficient 'f' depends upon Reynolds number and the relative roughness of the pipe. Drip irrigation laterals are generally made of smooth material. Flow in laterals is generally turbulent at its upstream end and flow becomes laminar at the downstream reach. The flow regime is characterised by the Reynolds number ($R_e$) and for cylindrical flow path is given by Hence, there is need to use more versatile DW equation with proper friction factors for estimation of pressure heads.

## Theoretical Considerations and Development

In general, the friction drop equation for pipe flows can be shown in simplified form as

$$\triangle H = kQ^m \triangle L \qquad (1)$$

where, $\triangle H$ = the total energy drop of a pipe section

k = constant for a given pipe size and type of flow

Q = discharge rate

$\triangle L$ = pipe section length

m = an exponent

Both the Hazen - Williams and Darcy - Weisbach equations are commonly used for estimation of frictional losses.

### Hazen - Williams Equation

Among all the equations, the Hazen - Williams formula is commonly and most frequently used (Keller and karmeli, 1975; Jeppson, 1982). The Hazen - Williams formula for smooth pipe (C = 150) can be shown as :

$$\triangle H = 15.27 \frac{Q^{1.852}}{D^{4.871}} \triangle L \qquad (2)$$

where, $\triangle H$ = energy drop by friction for a given pipe length ($\triangle L$), m

Q = discharge rate, $1\ s^{-1}$

$\triangle L$ = length of pipe, m

D = inside diameter of the pipe, cm

The above equation modified into the following form is used in computation of frictional head loss

$$H_f = \frac{3152.7375\ LQ^{1.852}}{C^{1.852} D^{4.871}} \qquad (3)$$

where, $H_f$ = frictional head loss, m

$$R_e = \frac{4\ Q}{k\ \eta\ \pi\ D} \qquad (6)$$

where, Q = flow rate in pipe, $1\ h^{-1}$

k = a constant equal to 3600

$\eta$ = kinematic viscosity of water, $m^2\ s^{-1}$

D = internal diameter of pipe, mm

Another form of the above Eq. 3.20 is

$$R_e = \frac{1.111 \times 10^{-3} Q}{\eta\ \pi\ D} \qquad (7)$$

Relationship between temperature and kinematic viscosity can be expressed as

$$\eta_T = 0.98^{(T-20)}\ \eta_{20} \qquad (8)$$

where, $\eta_T$ = kinematic viscosity of water at temperature, T°C

T = temperature of water in °C

$\eta_{20}$ = kinematic viscosity of water at 20°C ($1.003 \times 10^{-6}\ m^2 s^{-1}$)

The friction loss coefficient for different flow regime is given by

For laminar flow

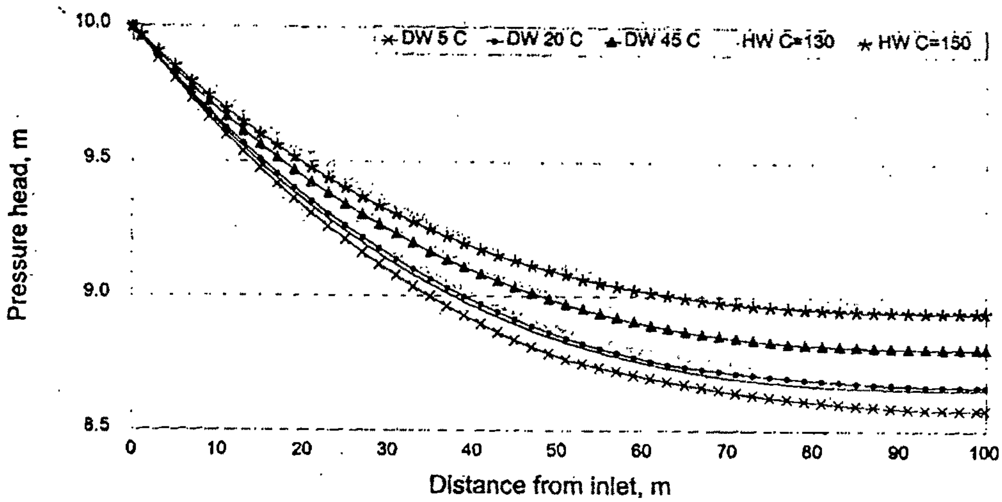

Fig. 1 Comparison of pressure heads along the lateral obtained with DW and HW equations.

$$f = 64\ R_e^{-1.0}\ (R_e < 4000) \qquad (9)$$

For turbulent flow, the Balsius equation is

$$f = 0.316\ R_e^{-0.25}\ (4{,}000 > R_e < 1{,}00{,}00) \qquad (10)$$

For fully turbulent flow

$$f = 0.130\ R_e^{-0.172}\ (R_e > 1{,}00{,}000) \qquad (11)$$

Substituting the value $R_e$ from Eq. (7) into Eq. (9) and then substituting the value of 'f' into Eq. (5) and by taking g = 9.81m $s^{-2}$, we have,

$$H_f = 1.1537 \times 10^6\ \eta\ LQD^{-4} \qquad (12)$$

Similarly substituting the value $R_e$ from Eq. (7) into Eq. (10) and then substituting the value of 'f' into Eq. (5) results in

$$H_f = 14.69\ \eta^{0.25}\ L\ Q^{1.75}\ D^{-4.75} \qquad (13)$$

and also by similar substitution of the value of Re from Eq. (7) into Eq. (11) and then substituting the value of 'f' into Eq. (5) results in

$$H_f = 3.2513\ \eta^{0.172}\ L\ Q^{1.828}\ D^{-4.828} \qquad (14)$$

The values of 'k' and 'm' in Eq. (1) for different flow regimes are given in the following table.

| Equation | Flow regime | k | m |
|---|---|---|---|
| | Laminar | $1.1537 \times 10^6\ \eta\ LD^{-4}$ | 1.0 |
| Darcy - Weisbach | Turbulent | $14.69\ \eta^{0.172}\ L\ D^{-4.826}$ | 1.75 |
| | Fully turbulent | $3.2513\ \eta^{0.172}\ L\ D^{-4.828}$ | 1.828 |
| Hazen - Williams | | $\frac{3152.7375\ L}{C^{1.852}\ D^{4.871}}$ | 1.852 |

*The symbols L. Q, D, and C carry same meaning as specified in earlier equations.*

## Comparison of DW and HW equations

In order to study the effect of use of Darcy Weisbach (DW) and Hazen Williams (HW) equations on frictional head loss estimation, a 12 mm lateral of 100 m length, an emitter of 4 lph discharge at 2m interval has been considered. Water temperatures of 5 °C, 20°C and 45 °C have been considered for pressure heads estimation using DW equation. A computer program was made for estimation of pressure heads along the lateral at different emission points. Simulations are also made using HW equation considering C value as 130 and 150. The variation in pressure heads along the lateral for five conditions assumed is shown in Fig. 1.

The comparison of pressure heads obtained with DW equation at the three water temperatures indicates that at higher water temperature there will be less head loss in the lateral and results in availability of more pressure heads at all nodal points. HW equation with C = 130 predicted lower pressure heads than with C = 150. The trends show that the pressure heads estimated with HW equation C = 130, are just equal to those obtained with DW equation with water temperature of 20°C. It indicates that at other water temperatures the HW equation with C = 130, may either under estimate or over estimate pressure heads. Hence use of C = 130 is valid for 12 mm lateral size when the water temperature is around 20°C. The HW equation with C = 150, under estimates the friction loss and over predicts heads available at nodal points in comparison to DW equation. DW equation has provision to consider effect of water temperature on change of friction factor and predicts pressure heads precisely than HW equation. Hence use of DW equation is recommended for friction loss estimation in the trickle irrigation pipes.

## Summary and Conclusions

Accurate estimation of frictional losses in the trickle pipes is an important aspect in optimizing the size of the trickle units. Both Hazen - Williams (HW) equation and Darcy - Weisbach (DW) equations were considered and necessary modifications were made and suitable constants were derived for estimation of frictional losses in the trickle pipes. A computer program is made to estimate frictional losses in the pipes by using both HW and DW equation considering different temperatures of water. For 12 mm lateral the pressure heads estimated at different nodal points along the lateral were compared for both HW and DW equations. Pressure heads estimated with HW equation with C = 130 were found to be very close to those obtained with DW equation at 20°C temperature. At other water temperatures estimates made with HW equation are either over or under estimated in comparison to DW equation. Hence use of DW equation with proper friction factors ensures better estimation of pressure heads along the trickle lateral.

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(Received on 02-06-2003 and revised on 10-09-2003)

*The Andhra Agric.* J. **50** (3&4) : 316 - 321, 2003

# Physico - Thermal Properties of Raw and Parboiled Wheat

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## ABSTRACT

The physical properties for raw and parboiled wheat at moisture contents ranging from 17.64 to 66.67% (d.b.) were determined using standard techniques. The physical properties such as : bulk density, true density, porosity and angle of repose of raw wheat were higher than that of parboiled wheat at any given moisture levels. It was found that the physical properties such as bulk density, true density decreased with increase of moisture content but in case of porosity and angle of repose it increased. Specific heat of raw wheat was lower than that of parboiled wheat. The physical - termal properties showed a linear relationship with moisture content.

**Key words :** Bulk density, true density, porosity, angle of repose, specific heat, raw and parboiled wheat.

India is one of the principal wheat producing and consuming countries in the world. Its importance in Indian agriculture is second to rice. It contributes about 42% of the total annual careal production of the world.

Wheat bulgur is a product of parboiled wheat. This is very popular in Western countries like; US and Canada, especially in prepared mixes in a quick cooking form and in frozen convenience foods. Parboiled wheat is also extensively used in some parts of India as a staple food, known as *dalia.* Parboiled wheat is generally prepared by the three major steps i.e. soaking, steaming and drying.

The knowledge of some important physical and thermal properties such as : density, porosity, angle of repose and specific heat etc. of different grains is necessary for the design or various separating and handling, storing and drying systems. The bulk density of grain determines the bin volume required to store a certain mass of grain. The void space in a mass of grain is expressed as a percentage of the total volume of the grain and is called the porosity. The angle of repose determines the maximum angle of a pile of grain with the horizontal plane.

## MATERIAL AND METHODS

The *Kalyan Sona* variety of wheat procured from the local market was used for this study. The wheat grains were cleaned by screening to remove foreign matter, broken, chaff and immature grains. This was followed by grading.

### Moisture conditioning of wheat

To study the effect of moisture content of wheat on some of the physical properties and thermal properties, samples of desired moisture levels were prepared by soaking in water at 70°C for predetermined time (Bandyopadhya and Ghosh, 1965). In case of parboiled samples, the wheat was soaked at 70°C for 30 minutes and steamed for 20 - 25 minutes at a pressure of 1.0 kg/cm$^2$ (gauge). The samples were dried in an oven at 50°C and then conditioned for about 12h. Conditioning of wheat was done by

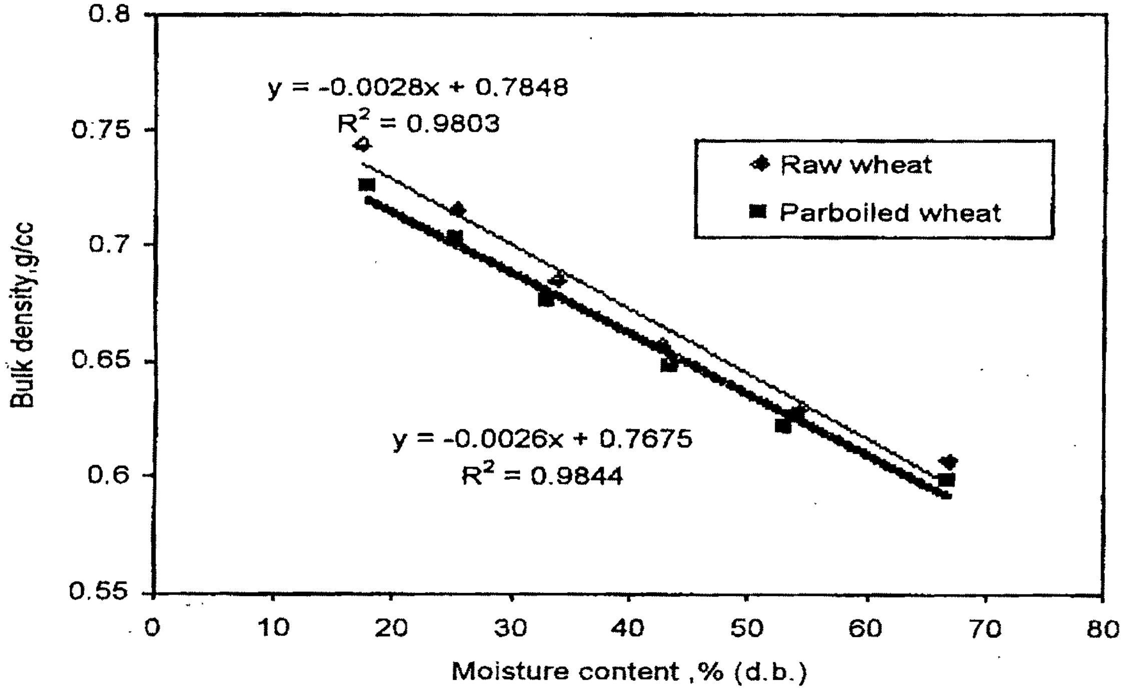

**Fig.1 Variation in bulk density with moisture content**

alternate wetting and drying. After oven drying for a certain period 3 to 5 per cent moisture was added and tempered for about 12h and again dried in the oven. The whole process of alternative wetting and drying was continued until sufficiently conditioned. Finally dried up to about 10 to 12% moisture content (Swamy, 2001). The conditioned samples were taken into sealed polyethylene bags to prevent moisture loss. The sample bags were kept at a low temperature in a refrigerator.

Before starting the experiment, wheat samples were taken out and were allowed to warm up to room temperature. At the beginning and end of each set of experiment, moisture content of the sample was determined. All physical properties of raw and parboiled wheat were determined at 7 levels of moisture ranging from 17.43 to 67 % (d.b.).

## Moisture determination

The moisture of a wheat sample was determined by drying about 10 g of sample in an oven at 105 ± 1 °C for 24 h (Araullo *et al.*, 1976). The samples were weighed on a precision electronic balance having least count of 0.001 g. Moisture content was calculated by the loss in moisture per unit weight of bone dry material of wheat.

## Physical Properties

### Density and Porosity

The bulk and true densities of both raw and parboiled wheat were determined at different moisture levels moisture content values of those ranges are not mentioned from 17.43 to 66.94 and 17.99 to 67.00% (d.b.), respectively. The bulk density ($\rho_b$) is the ratio of the mass of grain sample to its volume. It was determined using

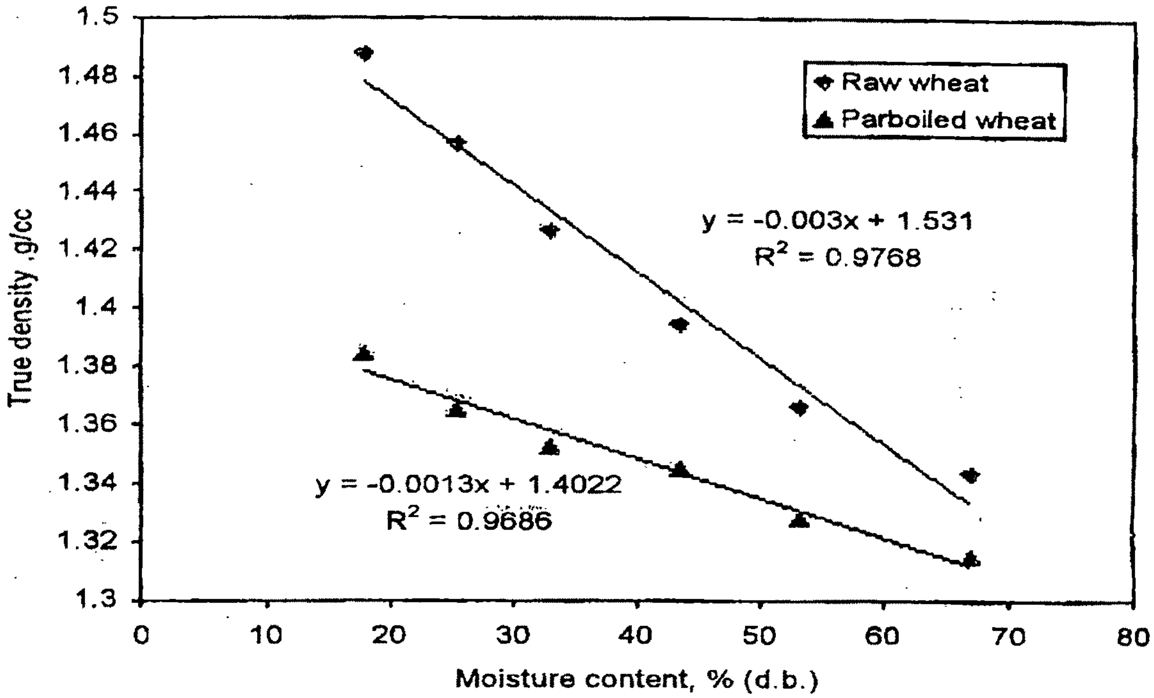

Fig.2 Variation in true density with moisture content

standard ohaus balance without tapping the material. The true density ($\rho_t$), defined as the ratio of mass of the sample to its true volume, was determined using multivolume pycnometer. Porosity (P) defined as the fraction of the space in the bulk grain, which is not occupied by the grain. The porosity was calculated from the relationship (Mohsenin, 1970); Porosity = (True density - Bulk density)/ True density.

### Angle of repose

The angles of repose ($\phi$) of both raw and parboiled wheat for the moisture ranging from 17.43 to 66.94 and 17.99 to 67.00% (d.b.) respectively were determined by a method described by Mohsenin (1970). The diameter ($D_c$) and the height ($H_c$) of the cone standing on a platform were measured. Angle of repose was calculated using the equation $\phi = \tan^{-1} (2H_c / D_c)$

## Thermal properties

### Specific heat

The specific heat of both raw and parboiled wheat for the moisture ranging from 17.64 to 66.67 and 15.23 to 40.07% (d.b.) respectively were determined by a method of mixtures. The experimental set up consisted of a calorimeter, sample holder and a thermometer (least count 0.1). The calorimeter employed was an ordinary vacuum thermo flask of one litre capacity. It was further insulated with about 40 mm thick thermocol around to minimize the heat losses. A hole was made in the screw lid just sufficient for inserting the thermometer. After inserting the thermometer the hole was sealed.

The calorimeter was filled with 150 g of distilled water at about 4 to 6°C temperature and shaken for about 10 min to attain equilibrium

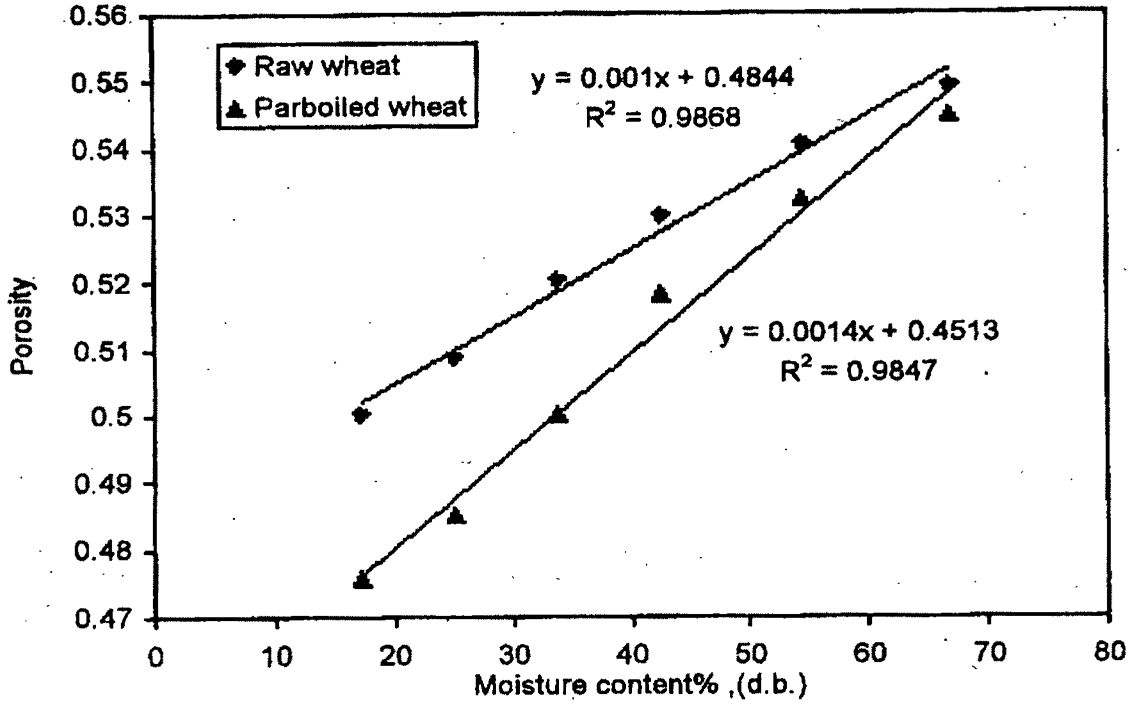

**Fig.3 Variation in porosity with moisture content**

temperature ($t_e$). Observing the temperature of water constantly with the help of thermometer and after ensuring constant equilibrium temperature, it was noted. The water equilient was calculated by solving heat balance.

$$W_e = W_{cw} \frac{(t_e - t_c)}{(t_f - t_e)}$$

where,

$W_e$ = water equivalent, cal / g$^0$C

$W_{cw}$ = weight of cold distilled water, g

$t_e$ = equilibrium temperature, $^0$C

$t_c$ = cold water temperature, $^0$C

Specific heat of wheat was determined by dropping the sample of known mass, $W_g$, and temperature, t, into the calorimeter containing water at $t_{cw}$. The equilibrium temperature, $t_e$, was recorded which reached within 5 min. However, shaking of calorimeter and observation of the temperature was continued for about 10 min.

$$C_p = \frac{W_{cw}(t_e - t_c) - W_e(t_e - t_c)}{W_g(t_f - t_e)}$$

where,

$C_p$ = specific heat, cal/g $^0$C

$W_g$ = weight of the grain, g

$t_r$ = temperature of the flask, $^0$C

## RESULTS AND DISCUSSION

### Physical Properties

### Bulk density

The bulk densities of both raw and parboiled wheat were measured at the moisture contents ranging from 17.43 to 66.94 and 17.99 to 67.00% (d.b.), respectively. The bulk density

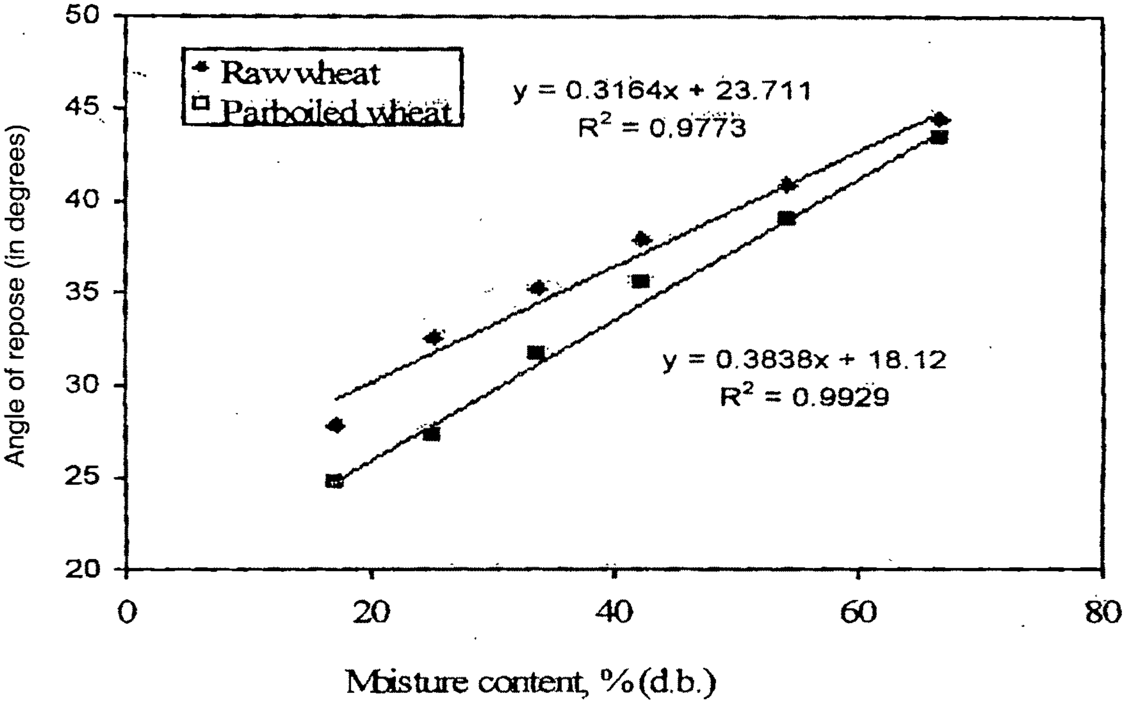

Fig.4 Variation in angle of repose with moisture content

of parboiled wheat was less than that of raw wheat at any given moisture content (Fig. 1). The bulk densities of both raw and parboiled wheat decreased with increase in moisture content (M) and bulk density ($\rho_b$) of raw and parboiled wheat are as follows.

$\rho_{br}$ = -0.028M + 0.7848 ----- (1) ($R^2 = 0.9791$)

$\rho_{bp}$ = -0.027M + 0.7697 ----- (2) ($R^2 = 0.9862$)

**True density**

The true densities of raw and parboiled wheat were found to vary from 1487 to 1343 kg/m³ and from 1384 to 1315 kg / m³ when the moisture level increased from 17.43 to 66.94 and 17.99 to 67.00% (d.b.), respectively (Fig. 2). The variations in true density ($\rho_t$) with moisture content (M) of raw and parboiled wheat were represented by the following regression equations :

$\rho_{tr}$ = -0.0031M +1.5403 ---- (3) ($R^2 = 0.9652$)

$\rho_{tr}$ = -0.0013M + 1.4017 ---- (4) ($R^2 = 0.9725$)

The equation (3) and (4) show that the true density of both raw and parboiled paddy varies linearly with the moisture content.

**Porosity**

The porosity was evaluated for the raw and parboiled wheat. It increased from 0.50 to 0.55 and 0.47 to 0.54 for raw and parboiled wheat, when their moisture content changed from 17.43 to 66.94 and 17.99 to 67.00% (d.b.), respectively (Fig. 3). The linear relationships between porosity (P) and moisture content (M) for raw and parboiled are as follows :

$\rho_r$ = -0.0010M +0.4879 ---- (5) ($R^2 = 0.9724$)

$\rho_p$ = -0.0015M + 0.4489 ---- (6) ($R^2 = 0.9767$)

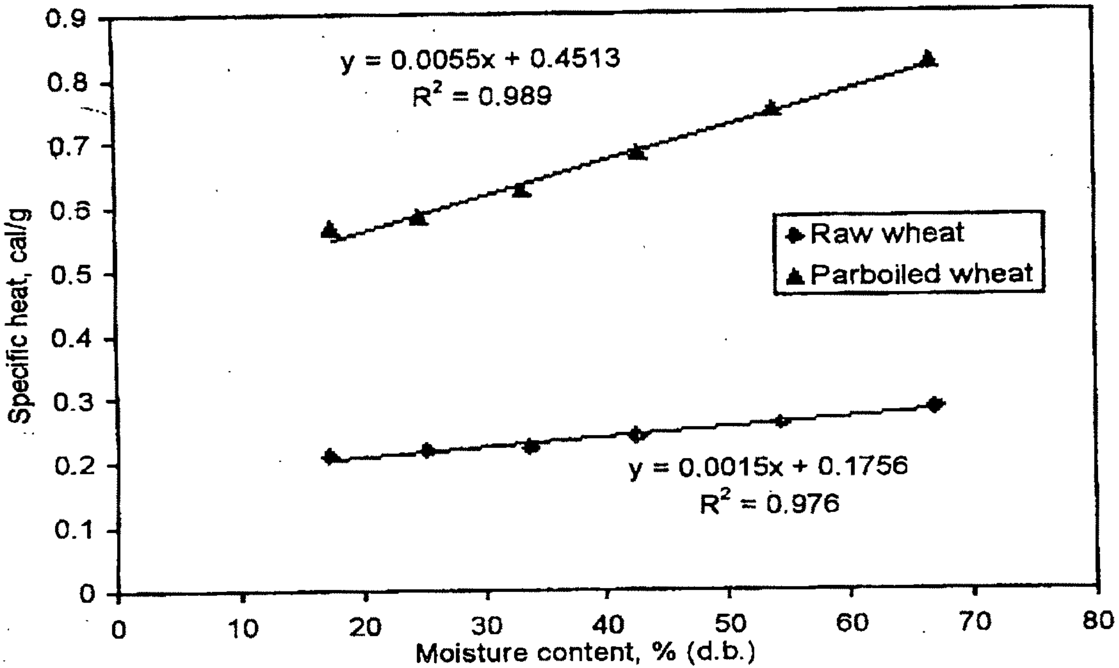

Fig.5 Variation in specific heat with moisture content.

### Angle of repose

The angles of repose of raw and parboiled wheat at different moisture contents are shown in (Fig. 4). These increased from 27.8 to 44.34 for raw and from 24.63 to 43.34 for parboiled wheat for the moisture ranging from 17.43 to 66.94 and 17.99 to 67.00 % (d.b.), respectively. The variation in angle of repose ($\phi$) with moisture content (M) can be represented by the following linear relationships.

$\phi_r = 0.3095M + 23.891$ ---- (7) ($R^2 = 0.9676$)

$\phi_p = 0.3880M + 18.209$ ---- (8) ($R^2 = 0.9841$)

### Thermal Properties

### Specific heat

The specific heat of raw and parboiled wheat at different moisture content is shown in (Fig. 5.). It is increased from 0.2067 to 0.2830 and 0.5645 to 0.8228 for raw and parboiled wheat, as moisture content increased from 17.64 to 66.67 and 15.23 to 40.07% (d.b.), respectively. These variations in specific heat (S) with moisture content (M) can be represented by the following linear relationships :

$S_r = 0.0059M + 0.4437$ --- (9.0) ($R^2 = 0.9612$)

$S_p = 0.0016M + 0.1755$ --- (10) ($R^2 = 0.9780$)

The linear equations (1) through (10) are good fit to the experimental data.

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(Received on 29-04-2002 and revised on 20-03-2003)

*The Andhra Agric.* J. **50** (3&4) : 322 - 326, 2003

# Constraints in Production and Marketing of Coffee : A Case Study in Visakhapatnam District

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## ABSTRACT

Coffee occupies a place of pride among the plantation crops grown in India. The present study is an attempt to study the production and marketing problems faced by the growers in the agency areas based on the data collected from a sample of 90 small tribal coffee growers of the study area. Results of the investigation indicated that the coffee growers getting low price to their produce, lack of domestic market in the local environment and exploited by the traders to a large extent.

**Key words :** Constraints, Marketing of Coffee.

Coffee is one of the important commercial plantation crops grown in India. It is the second largest traded commodity in the world after crude oil in India. Coffee is mainly grown in Southern States of Karnataka, Kerala, Tamilnadu, Andhra Pradesh and Orissa. Coffee is predominantly grown in the Agency areas of Visakhapatnam district of Andhra Pradesh covering an area of 16000 ha and 2230 MT of production. The present area of small - holder tribal coffee is 11,600 ha owned by around 24,000 farming families. The coffee plantations were raised in the Agency areas of the district to wean out the small tribal farmers away from the pernicious practice of **podu** cultivation. This helped in the improvement of Socio - Economic status of local poor and illiterate tribal inhabitants. But the tribal coffee growers face many production and marketing problems and they are not getting adequate economic returns.

This study was taken up with the major objective of assessing the problems faced by the tribal coffee growers in production and marketing of coffee and to suggest remedies based on the findings of the study.

## METHODOLOGY

**Paderu** division of Visakhapatnam district is purposively selected, since coffee grows well in the hilly areas. Then based on the maximum crop area, three mandals **G.K.Veedhi, Chintapalli** and **Paderu** were selected and two villages from each mandal were selected based on the age groups of coffee plantations as 21, 30 and 39 farmers under less than 5, 5-10 and above 10 years age groups respectively. The data for the study were collected by the survey method from 90 sample coffee growers by personal interview method on various aspects of production and marketing problems faced by them. The study pertains to the year 1999 - 2000.

## RESULTS AND DISCUSSION

Table 1 indicates the problems faced by the small tribes in production and marketing of

Table 1 : Opinion Survey Regarding the Production Problems in Coffee Cultivation

| Particulars | Young garden (< 5 years) | | Middle aged garden (5 - 10 years) | | Aged garden (above 10 years) | |
|---|---|---|---|---|---|---|
| | Yes | No | Yes | No | Yes | No |
| 1. Is coffee cultivation profitable | 19<br>(90.47) | 2<br>(9.52) | 30<br>(100.00) | - | 39<br>(100.00) | - |
| 2. Is there any scope of increasing the area under coffee | 11<br>(52.38) | 10<br>(47.62) | 16<br>(53.33) | 14<br>(46.67) | 15<br>(38.46) | 24<br>(61.54) |
| 3. Timely availability of planting material | 10<br>(47.62) | 11<br>(52.38) | - | - | - | - |
| 4. Low yields | | | | | | |
| 1. Do you practice improved agricultual practices | | | | | | |
| a) Weeding | | | | | | |
| (i) 3 times | 5<br>(23.80) | 16<br>(76.19) | 8<br>(26.67) | 22<br>(73.33) | 7<br>(22.50) | 32<br>(82.05) |
| (ii) 2 times | 16<br>(76.19) | 5<br>(23.08) | 22<br>(73.33) | 8<br>(26.67) | 32<br>(82.05) | 7<br>(22.50) |
| b) Lining | 21<br>(100.00) | - | 30<br>(100.00) | - | 39<br>(100.00) | - |
| c) Shade regulation | 10<br>(47.62) | 11<br>(52.38) | 13<br>(43.33) | 17<br>(56.67) | 19<br>(48.72) | 20<br>(51.28) |
| d) Handling, centring and and pruning | 8<br>(38.09) | 13<br>(61.90) | 15<br>(50.00) | 15<br>(50.00) | 16<br>(41.02) | 23<br>(58.97) |
| e) Topping and Desuckering | 6<br>(28.57) | 15<br>(71.43) | 12<br>(40.00) | 18<br>(60.00) | 9<br>(23.07) | 30<br>(76.92) |
| 2. Do you apply recommended dosage of fertilizers | 6<br>(28.57) | 15<br>(71.43) | 10<br>(33.33) | 20<br>(66.67) | 7<br>(17.91) | 32<br>(82.05) |
| 3. Do you apply recommended plant protection chemicals | 3<br>(14.28) | 18<br>(85.71) | 5<br>(16.67) | 25<br>(83.33) | 6<br>(15.38) | 33<br>(84.62) |
| 5. Inadequate credit facilities | 8<br>(38.09) | 13<br>(61.90) | 17<br>(56.67) | 13<br>(43.33) | 19<br>(48.72) | 20<br>(51.28) |
| 6. Are you getting any teachnical advise | 10<br>(47.62) | 11<br>(52.38) | 16<br>(53.33) | 14<br>(46.67) | 29<br>(74.36) | 10<br>(26.64) |
| 7. Do you visit Coffee Board Officials | 4<br>(19.05) | 17<br>(30.95) | 15<br>(50.00) | 15<br>(50.00) | 17<br>(43.58) | 21<br>(53.85) |
| 8. Visits made by officials once in | | | | | | |
| (a) a week | 5(23.81) | | 10(33.33) | | 15(38.46) | |
| (b) 15 days | 12(57.14) | | 11(36.67) | | 20(51.28) | |
| (c) a month | 3(14.29) | | 6(20.00) | | 4(10.26) | |
| (d) Nil | 1(4.76) | | 3(10.00) | | -- | |

Table 2 : Reasons for non-adoption of improved agricultural practices and improper application of fertilizers, manures and pesticides.

| S.No. | Particulars | Young garden (< 5 years) | Middle aged garden (5 - 10 years) | Aged garden (above 10 years) |
|---|---|---|---|---|
| A. | Improper application | | | |
| 1. | Lack of technical know-how | 16<br>(76.19) | 14<br>(46.67) | 13<br>(33.33) |
| 2. | Hike in prices of chemicals and fertilizers | 18<br>(85.71) | 17<br>(56.67) | 15<br>(38.46) |
| 3. | Shortage of capital | 15<br>(71.43) | 18<br>(60.00) | 20<br>(51.28) |
| 4. | Non - availability | 2<br>(9.52) | 3<br>(10.00) | 2<br>(5.13) |
| 5. | Inadequate advisory services | 15<br>(71.43) | 13<br>(43.35) | 17<br>(43.59) |
| B. | Improved agricultural practices | | | |
| 1. | Lack of knowledge | 14<br>(66.67) | 12<br>(40.00) | 10<br>(25.64) |
| 2. | Shortage of capital | 11<br>(52.38) | 10<br>(33.33) | 8<br>(20.51) |
| 3. | High labour wages | 8<br>(38.09) | 9<br>(30.00) | 7<br>(17.95) |
| 4. | Lack of training | 15<br>(71.43) | 13<br>(43.33) | 15<br>(38.46) |
| 5. | Lack of advisory services | 12<br>(57.14) | 10<br>(33.33) | 16<br>(41.02) |
| 6. | Lack of suitable implements | 18<br>(85.71) | 22<br>(73.33) | 21<br>(53.85) |
| 7. | Lack of insurance | 19<br>(90.47) | 20<br>(66.67) | 15<br>(38.46) |

coffee through the opinion survey. Compared to Coffee Board and other State agencies like Andhra Pradesh Forest Development Corporation (APFDC), the tribal farmers get low yields. This is because 52.38 per cent of young garden, 56.67 per cnt of middle aged and 51.28 per cent of aged garden farmers do not practice the important operation like shade regulation. Handling, centering and pruning operations are not followed by 61.09, 40.00 and 58.97 per cent of young, middle and aged garden farmers respectively. The farmers do not apply the recommended dosage of fertilizers and plant protection chemicals. The tribal do not even show interest to attend the training programmes conducted by Coffee Board and Regional Coffee Research Station (RCRS). The attended tribes also may not practice the techniques perfectly. This may be due of young, middle aged and aged garden farmers do not visit Coffee Board officials. With regard to the interaction of farmers with the officials, 57.14, 36.67 and 51.28 per cent of young, middle and old aged garden farmers indicated that the higher authorities visited their fields once in 15 days while 23.81, 33.33 and 38.46 per cent of young, middle and old aged garden farmers indicated that the officials visited once in a week. The various reasons for the non-adoption of improved agricultural practices and improper application of fertilizers, manures and pesticides represented in the table 2. Hike in prices of chemicals and fertilizers and shortage of capital are the major constraints for the improper application of manures and fertilizers.

## MARKETING PROBLEMS

The main marketing problems faced by the tribal coffee farmers are low price to their produce, price fluctuations, exploitation by the traders, lack of market in the domestic environment, unaware of market prices, low demand and consumption, production in small lots and low quality produce. 76.19 per cent of young garden, 66.67 per cent of middle and old aged garden farmers revealed that they are being exploited by the traders. To overcome the problem, they formed small tribal coffee farmers association especially in Chintapalli region. But these associations failed due to some political reasons. So, each individual farmer selling the produce in small lots is not getting remunerative price to his produce. Lack of market in the domestic enionment regarded as the main marketing problem by 57.14, 66.67 and 61.54 per cent of young, middle and old aged gardens respectively.

Almost all the coffee, produced by the small growers converted into cherry coffee preparation depriving them of the advantages of higher realization simply because they do not have appropriate and viable means of achieving better value addition. They even lack hygienic and clean drying yards in their farms to prepare good quality cherry coffee.

## CONCLUSION AND SUGGESTIONS

In the light of the findings of the study, it can be understood that the tribal coffee farmers are facing many production and marketing problems. The following recommendations are made to minimize the crisis situation and to maintain a sustainable profit in coffee production.

- Intensive training programmes and field demonstrations must be conducted to convince the farmers to adopt the mproved agricultural practices.
- The State Government should provide (i) financial assistance to coffee development programmes. (ii) ITDA (Integrated Tribal Development Agency) be strengthened to support coffee development programmes. (iii) establish more coffee curing works (iv) Provide coffee auction platforms (v) improve education, health, transport and communication facilities.
- Growers price should be on the basis of cost of cultivation of coffee in that particular year.
- The crop insurance may be introduced which provides a safety net for the coffee growers to take greater risk through the enhancement

Table 3 : Marketing problems faced by the tribal coffee farmers.

| Particulars | Young garden (< 5 years) | | Middle aged garden (5 - 10 years) | | Aged garden (above 10 years) | |
|---|---|---|---|---|---|---|
| | Yes | No | Yes | No | Yes | No |
| Low price to the produce | 18<br>(85.71) | 3<br>(14.28) | 25<br>(83.33) | 5<br>(16.67) | 25<br>(64.10) | 14<br>(35.89) |
| Price fluctuations | 15<br>(71.43) | 6<br>(28.57) | 22<br>(73.33) | 8<br>(26.67) | 30<br>(76.92) | 9<br>(23.07) |
| Exploitation by the traders | 16<br>(76.19) | 5<br>(23.81) | 20<br>(66.67) | 10<br>(33.33) | 26<br>(66.67) | 13<br>(33.33) |
| Low demand and consumption | 10<br>(47.62) | 11<br>(52.38) | 14<br>(46.67) | 16<br>(53.33) | 20<br>(66.67) | 19<br>(48.72) |
| Lack of market in the domestic environment | 9<br>(42.86) | 12<br>(57.14) | 10<br>(33.33) | 20<br>(66.67) | 15<br>(38.46) | 24<br>(61.54) |
| Unaware of market prices | 5<br>(23.81) | 16<br>(76.19) | 12<br>(40.00) | 18<br>(60.00) | 8<br>(20.51) | 31<br>(79.49) |
| Production in small lots | 11<br>(52.38) | 10<br>(47.62) | 15<br>(50.00) | 15<br>(50.00) | 19<br>(48.72) | 20<br>(51.28) |
| Low quality produce | 8<br>(38.09) | 13<br>(61.91) | 11<br>(36.67) | 19<br>(63.33) | 9<br>(23.08) | 30<br>(76.92) |

of their investment under uncertain monsoon and price fluctuation induced crisis.

- Self - Help Groups must be formed to provide institutional support to small growers to process and market their coffees and also to avail financial assistance from the institutions.
- The market information to the growers sector on day-to-day basis must be disseminated from the Coffee Board Market Intelligence unit.

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(Received on 10-12-2001 and revised on 10-07-2003)

*The Andhra Agric.* J. **50** (3&4) : 327 - 331, 2003

# Resource Productivity of Mesta Farms in Srikakulam District of Andhra Pradesh

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## ABSTRACT

Mesta fibre accounts for 70 per cent of raw jute. The cultivation involves intensive human labour in addition to manures and fertilizers, seed and cattle labour. The Cobb-Douglas production function analysis for these variables indicated constant returns to scale on all farm size groups. The marginal value product to opportunity cost ratios for all farm size groups indicated resource use inefficiency and revealed the scope for adjustments and reorganization of resources, so as to obtain high returns in mesta cultivation.

**Key words :** Purposively, Predominantly, aggregate, Cobb-Douglas.

Mesta, vernacularly known as Gogu is predominantly grown in Vizianagaram and Srikakulam districts in Andhra Pradesh. The fibre extracted from mesta is admixed with jute fibre and technically known as raw jute. An attempt has been made to the study on resource returns, returns to scale and resource use efficiency of mesta to judge how efficiently the inputs have been utilized in obtaining outputs.

## MATERIAL AND METHODS

Srikakulam District has been purposively selected for the study, as it covers 20,050 hectares area under mesta cultivation. Three predominant mesta growing mandals purposively selected for the study are Rajam, Etcherla and Regidi Amadalavalasa. The sample for the study consisted of 30 small, 30 medium and 30 large farmers, i.e., an aggregate of 90 farmers. Cobb-Douglas production model has been used in the present study due to ease in computation and simplicity in interpretation (Cobb and Douglas, 1928). The production function has been fitted for each size as well as for the totality of farms. Further the function has been fitted separately considering output in value terms. The drawback with this function is that it allows either constant, increasing or decreasing marginal productivity and not an input-output curve embaracing all the three stages.

## RESULTS AND DISCUSSION

The Cobb-Douglas production function has been fitted for small, medium, large and all farms considering the four independent variables *viz.,* seed, manures and fertilizers, human labour and cattle labour evaluated in monetary terms per farm. The problem of multicollinearity was tested by computing the zero order correlation matrices. It was observed that the co-efficient of multiple determination ($R^2$) was more than simple correlation coefficient (r) of selected variables.

The functional model adopted was of the form :

$$Y = aX_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4}$$

The function in log form is represented as

$$\text{Log } Y = \text{Log } a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + Ut$$

Where.,

Y = Gross returns in rupees

$X_1$ = Seed in rupees

$X_2$ = Manures and fertilizers in rupees

$X_3$ = Human labour in rupees

$X_4$ = Cattle labour in rupees

$b_1$ to $b_4$ = Production elasticities of factors $X_1$ to $X_4$

a = intercept

Ut = Under ten

This power function was transformed into log linear on function for the estimation. The coefficients are estimated by using Least Square Method.

Production elasticities and their respective standard errors are given in Table - 1 for small, medium, large and all farms. The co-efficient of multiple determination ($R^2$) was 0.86, (86%) 0.93, (93%) 0.88 (88%) and 0.95 (95%) in small, medium, large and all farms respectively. This implies that 86, 93, 88 and 95 per cent of variation in gross returns could be explained by the selected input variables in small, medium,

Table 1 : Production elasticities and selected statistics (monetary) of mesta

| Particulars | Small farmers | Medium farmers | Large farmers | All farms |
|---|---|---|---|---|
| Number of farms | 30 | 30 | 30 | 90 |
| Constant (log a) | 1.48.894 | 1.288745 | 1.051330 | 0.877349 |
| **Production elasticities** | | | | |
| Seed (Rs.) | -0.002374 | -0.077144 | 0.114992 | 0.067545 |
| Manures and fertilizers (Rs.) | 0.079129 | 0.083595 | 0.245349** | 0.149331* |
| Human labour (Rs.) | 0.453076** | 0.233943* | 0.589157** | 0.669776** |
| Cattle labour (Rs.) | 0.379442* | 0.871850** | 0.026119 | 0.139489 |
| Sum of elasticities (bi) | 0.909272 | 1.112244 | 0.975617 | 1.026140 |
| R2 | 0.864194 | 0.9383118 | 0.8879181 | 0.9590451 |
| **Standard error** | | | | |
| Seed | 0.135773 | 0.196744 | 0.136779 | 0.072969 |
| Manures and fertilizers | 0.154811 | 0.070279 | 0.107388 | 0.070351 |
| Human labour | 0.171327 | 0.095000 | 0.178703 | 0.089470 |
| Cattle labour | 0.181660 | 0.215984 | 0.105991 | 0.078177 |
| **Geometric mean** | | | | |
| Output (Rs.) | 4.010775 | 4.651192 | 4.736190 | 4.463768 |
| Seed (Rs.) | 20406018 | 3.040125 | 3.088929 | 2.846820 |
| Manures and fertilizers (Rs.) | 2.999672 | 3.528045 | 3.517614 | 3.359106 |
| Human labour (Rs.) | 3.329541 | 3.971624 | 4.063006 | 3.788709 |
| Cattle labour (Rs.) | 8.081209 | 2.721699 | 2.789767 | 2.544486 |

** Significant at 1 per cent level

* Significant at 5 per cent level.

large and all farms respectively. The value of $R^2$ was highly significant in all the four situations.

The sum of elasticities of resources is an indicator of the returns to scale. It is obvious from the table that the sum of elasticities was 0.909272 in small farms and 1.112244 in medium farms, 0.975617 in large farms 1.026140 in all farms. The results of the 't' test proved that in all four groups of mesta farms Σ bi was not deviating significantly from unity, indicating constant returns to scale. This is in confirmation with the study conducted by Choudhury in 1987.

In small and medium farms, human labour and cattle labour showed significant and positive relationship indicating that these inputs influence the production process. The production elasticities indicated that one per cent increase in human labour in small and medium farms would increase the gross output by 0.45 and 0.23 per cent respectively when all the other factors are kept constant. Similarly one per cent increase in cattle labour in small and medium farms would increase the gross output by 0.37 and 0.87 per cent respectively, when all the other factors are kept constant. However, negative sign to the co-efficient of input, seed in both the farms indicated the excessive use of this input in the production process. The production elasticities of seed and manures and fertilizers which were not significant indicated that these inputs were not exerting significant influence on gross returns. However, negative sign to the co-efficient of input, seed indicated the excessive use of this input in the production process. The large farms revealed that production elasticities of manures, fertilizers and human labour to be highly significant at one per cent level. Keeping all other inputs constant, one per cent increase in manures, fertilizers and human labour world increase the gross returns by 0.24 and 0.58 per

Table 2 : Marginal value products, opportunity costs and ratios of MVP to opportunity costs (Monetary)

| Particulars | Small farmers | Medium farmers | Large farmers | All farms |
|---|---|---|---|---|
| **Marginal value products (MVP) (Rs.)** | | | | |
| Seed | -0.0040 | -0.1180 | 0.1763 | 0.1089 |
| Manures and fertilizers | 0.1008 | 0.1102 | 0.3308 | 0.1984 |
| Human labour | 0.5458 | 0.2740 | 0.6868 | 0.7891 |
| Cattle labour | 0.7312 | 1.4899 | 0.0443 | 0.2447 |
| **Opportunity costs (OC)** | | | | |
| Seed | 1.00 | 1.00 | 1.00 | 1.00 |
| Manures and fertilizers | 1.00 | 1.00 | 1.00 | 1.00 |
| Human labour | 1.00 | 1.00 | 1.00 | 1.00 |
| Cattle labour | 1.00 | 1.00 | 1.00 | 1.00 |
| **MVP to OC ratio** | | | | |
| Seed | -0.0040 | -0.1180 | 0.1763 | 0.1089 |
| Manures and fertilizers | 0.1008 | 0.1102 | 0.3308 | 0.1984 |
| Human labour | 0.5458 | 0.2740 | 0.6868 | 0.7891 |
| Cattle labour | 0.7312 | 1.4899 | 0.0443 | 0.2447 |

## Appendix A

Zero-order correlation matrix for mesta - monetary

| Variables | Y | X1 | X2 | X3 | X4 |
|---|---|---|---|---|---|
| **A. Small farms** | | | | | |
| Y | 1.0000 | 0.8248 | 0.8020 | 0.9024 | 0.8997 |
| X1 | | 1.0000 | 0.7058 | -0.8620 | 0.8693 |
| X2 | | | 1.0000 | -0.7958 | 0.8375 |
| X3 | | | | 1.0000 | 0.8823 |
| X4 | | | | | 1.0000 |
| $R^2 = 0.8641$ | | | | | |
| **B. Medium farms** | | | | | |
| Y | 1.0000 | 0.9149 | 0.6884 | 0.8818 | 0.9575 |
| X1 | | 1.0000 | 0.6188 | 0.8259 | 0.9590 |
| X2 | | | 1.0000 | 0.6178 | 0.6558 |
| X3 | | | | 1.0000 | 0.8478 |
| X4 | | | | | 1.0000 |
| $R^2 = 0.9383$ | | | | | |
| **C. Large farms** | | | | | |
| Y | 1.0000 | 0.7725 | 0.7966 | 0.9280 | 0.7445 |
| X1 | | 1.0000 | 0.4720 | 0.8374 | 0.7034 |
| X2 | | | 1.0000 | 0.7521 | 0.6390 |
| X3 | | | | 1.0000 | 0.7629 |
| X4 | | | | | 1.0000 |
| $R^2 = 0.8879$ | | | | | |
| **D. All farms** | | | | | |
| Y | 1.0000 | 0.9139 | 0.9030 | 0.9749 | 0.9357 |
| X1 | | 1.0000 | 0.7905 | 0.9280 | 0.9136 |
| X2 | | | 1.0000 | 0.9009 | 0.8779 |
| X3 | | | | 1.0000 | 0.9359 |
| X4 | | | | | 1.0000 |
| $R^2 = 0.9570$ | | | | | |

cent respectively. Rao (1979) reported that the production elasticities of manures and fertilizers, seed and land was positively significant. Production elasticities of all farms recorded human labour, manures and fertilizers to be significant at one (1%) per cent. Keeping all other inputs constant, an increase in expenditure of human labour manures and fertilizers by one per cent would increase the gross returns by 0.66 and 0.14 per cent respectively. The production elasticities of seed and cattle labour were found to be non significant indicated that these inputs were not exerting significant influence on gross returns.

The Cobb-Douglas frame work requires the estimation of marginal value products (MVP) of the resources to determine efficient resource use. It is calculated at Geometric mean levels and the knowledge of marginal return of resources is useful as it gives the level at which it is economical for the farmers to adopt the new technology and to have resource adjustment. The general approach for judging the efficiency of resource use is to compare the marginal return with marginal cost. In other words, when marginal value products of inputs considered along with the factor opportunity costs, it indicates the efficiency with which resources have been put under use. MVP's for rupee of expenditure incurred on seed, manures and fertilizers, human labour and cattle labour are computed and compared with the opportunity costs. Since the variables seed, manures and fertilizers, human labour and cattle labour in the production function are taken in value terms, the opportunity costs of each of them become one rupee.

The estimated MVP's of all the inputs of mesta were tested using 't' test, to find out whether MVP and acquisition cost were significantly differing. The marginal value products, opportunity costs, ratio of MVP to OC values are presented in Table - 2.

The MVP to OC values in small, medium, large and all farms revealed that the utilization of the inputs viz., were less than acquisition costs (1.00). This implies that seed, manures and fertilizers, human labour and cattle labour were used inefficiently on all size group of farms in mesta cultivation. This is in confirmation with the study of Naidu, 1991 who stated that there is scope for reorganization of resources to achieve higher profits.

## Conclusions

Cobb-Douglas production function was fitted to small, medium, large and all farm size groups considering four independent variables *viz.,* seed, manures and fertilizers, human labour and cattle labour. The co-efficient of multiple determination ($R^2$) indicated that the selected variables had explained 86,93,88 and 95 per cent variation in gross returns of mesta in case of small, medium, large and all farms respectively. The sum of production elasticities ($\Sigma$ bi) indicated constant returns to scale. The ratio of marginal value products to the opportunity costs revealed that all the variables viz., seed, manures and fertilizers, human labour and cattle labour were used inefficiently on small size group of farms in the cultivation of mesta.

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(Received on 30-05-2002 and revised on 18-03-2003)

*The Andhra Agric.* J. **50** (3&4) : 332 - 336, 2003

# Temporal Variations Under Pre and Post Watershed Management Programme

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## ABSTRACT

The present study was taken upto enlighten the impact of watershed management on several selected parameters in half a decade time and Chinnatekur watershed of Kurnool district of Andhra Pradesh was selected for the purpose. The data pertaining to the selected parameters for the period 1982 - 83 and 1987 - 88 was elicited from the records of the local office of the State Department of Agriculture. The data on land use pattern indicated a radical change between pre and post watershed period. The dry-cum-wet area indicated an increase while dry land area reduced between pre-and post watershed. The cropping pattern indicated a considerable variation in cropping systems like mixed cropping and new crops are also introduced like red gram in five - year period of watershed management.

**Key words :** Temporal Variations, Watershed, Management.

The per hectare incomes indicated a continuous increase both in dry and ID conditions. The fertilizer consumption indicated a spectacular increase and the agricultural production pattern revealed that the pulses and oilseeds production increased tremendously between the period 1982 - 83 and 1987 - 88. Conclusions were drawn that watershed management do provide employment opportunities in the area as the programme brings radical changes in the land use and cropping pattern.

Watershed management the name itself implores that the shed water obtained i.e., either through rainfall, exploitation of ground water or open wells is to be managed in a suitable way with the help of various agricultural engineering methods and by soil conservation, by collection of run off water into farm ponds and also by constructing rock fill bans to conserve scarce water. The watershed management programme mainly aims at the places where scarce rainfall prevails and where canal irrigation provision is not possible in the near future. The irrigation facilities would bring in radical changes in the land use pattern, cropping pattern and thereby helps in increasing farmer's incomes in the area. The watershed management, which is an irrigation programme, also brings in similar changes to the specified watershed area.

The present study is an attempt to enlighten the impact of watershed management on several selected parameters in half a decade time length i.e., between 1982-83 and 1987-88.

## METHODOLOGY

The data pertaining to land use pattern, cropping pattern, income per hectare and other information pertinent to Chinnatekur watershed, Kurnool district, Andhra Pradesh was elicited

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Table 1 : Land use pattern under pre-watershed and post-watershed period (Area in hectares) in Chinnatekur.

| | Pre watershed (1982-83) | | Post - watershed (1987-88) | |
|---|---|---|---|---|
| | Area | Percentage total | Area | Percentage total |
| Total area | 1120.11 | | 1120.11 | |
| Dry-cum-wet | 12.55 | 1.12 | 129.22 | 11.54 |
| Supplemental Irrigation (gran paid, nala board, rock fill dams) | -- | -- | 17.80 | 1.59 |
| Dry - land | 653.02 | 58.30 | 455.97 | 40.70 |
| Wet - land | 100.36 | 8.96 | 100.36 | 8.96 |
| Well irrigation | 49.26 | 4.40 | 100.28 | 8.95 |
| Others | 301.92 | 27.20 | 316.48 | 28.26 |
| Cropping intensity | | | | 140.27% |

from the records available with local office of State Department of Agriculture. The data was compared for the periods between 1982-83 (pre-watershed) and 1987-88 (post watershed).

## RESULTS AND DISCUSSION

The results and discussion are conveniently presented according to the parameters selected for the purpose.

### Land use pattern

This is basic and important parameter, which reflects irrigation water impact even to naked eye and hence this parameter was selected. The data pertaining to land use pattern for the period, pre water shed (1982-83) and post watershed (1987-88) was presented in Table 1. The striking feature of the data is that there is an increase in dry-cum-wet area from a meager 12.55 to 129.22 hectares, while the dry land area decreased from 653 to 453 hectares between pre and post watershed periods. The area under well irrigation is also increased. The above phenomenon is quite natural, since the water shed management main objective is to conserve vital natural resource i.e., water so as to make use it at the times of necessities. Thus, it can be inferred that the watershed management brings in a radical change in land use pattern even in a half a decade time. The cropping intensity indicated 140.27 per cent under post watershed period.

### Cropping Pattern

The parameter was selected to study the impact of watershed on the changes in cropping pattern in half a decade time. The cropping pattern (Table 2) indicated significant variation between pre and post watershed period. Under pre-watershed period, the major crops under rainfed conditions were only setaria (68.20ha.), groundnut (52.22ha.) and jowar (47.47ha.) and occupied 32.80, 25.10 and 22.80 per cent respectively to total rainfed area, while paddy (37.31 ha.), jasmine (14.86 ha.), vegetables (10.40 ha.) were the main crops, where paddy alone occupied 49.30 per cent total irrigated area.

Under post watershed period the data (Table 2) clearly purports that there is greater variation in five years in the cropping pattern. The data indicated that mixed cropping system i.e., groundnut + red gram occupied an area of 256.66 hectares under *kharif* rainfed conditions followed by setaria + red gram (40.40 hectares). Thus, new agronomic practices were introduced to utilize moisture in a most fitted way under post

Table 2 : Cropping pattern under pre-watershed and post-watershed period.

| Pre-watershed (1982-83) | | | | | Post-watershed (1987-88) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Farming type | Crop | Area (ha) | Percentage to total | Average yield (q ha$^{-1}$) | Farming type | Crop | Area (ha) | Percentage to total | Average yield (q ha$^{-1}$) |
| Rainfed | Setaria | 68.20 | 32.80 | 3.22 | Rainfed *Kharif* | Groundnut | 35.30 | 8.30 | 6.30 |
| | Groundnut | 52.22 | 2510 | 3.90 | | Groundnut + red gram | 256.66 | 60.25 | 6.73 + 10.76 |
| | Jowar | 47.47 | 22.80 | 4.30 | | Setaria + red gram | 40.40 | 9.50 | 6.94 + 8.30 |
| | Others | -- | 19.30 | -- | | Others | -- | 21.95 | -- |
| | | | 100.00 | | | | | 100.00 | |
| Irrigated | Paddy | 37.31 | 49.30 | 20.00 | *Rabi* | Relay jowar in groundnut | 65.00 | 37.00 | 4.55 |
| | Jasmine | 14.86 | 19.60 | 16.74 | | Pure jowar | 97.00 | 55.30 | 3.35 |
| | Vegetables | 10.40 | 13.70 | 38.46 | | Others | -- | 7.70 | -- |
| | Others | -- | 17.40 | -- | | | | 100.00 | |
| | | | 100.00 | | Irrigated (Tank) | | | | |
| | | | | | *Kharif* | Paddy | 114.00 | 100.00 | 47.00 |
| | | | | | *Rabi* | -- | -- | -- | -- |
| | | | | | Irrigated dry (Tank, well, nala) | Groundnut | 37.65 | 19.74 | 24.80 |
| | | | | | | Jasmine | 48.53 | 25.45 | 18.72 |
| | | | | | | Onion | 26.24 | 13.76 | 16.21 |
| | | | | | | Vegetables | 18.34 | 9.61 | 40.31 |
| | | | | | | Others | -- | 31.44 | -- |
| | | | | | | | | 100.00 | |

watershed period as the area under mixed cropping accounted for 70 per cent to total rainfed area whereas under *rabi* rainfed conditions, jowar with 55 per cent to total *rabi* area occupied major area followed by relay jowar in groundnut (37%). Under irrigated dry conditions in *rabi* season priority was given to jasmine (25.45%) followed by groundnut (19.74%) and onion (26.24%), which requires only interval irrigations. Thus, the above discussion clearly establishes that there are significant variations in the cropping pattern so as to conserve the moisture in a most suitable way and also to increase the productivity.

The data on productivity of the crops (Table 2) indicated an increase between the pre and post-watershed periods. The productivity of paddy and setaria increased by more than 100 per cent in half a decade time, while the productivity of groundnut increased by 80% with no change in jowar. The newly introduced crop in the watershed area i.e., red gram has also

Table 3 : Net income per hectare under different systems of farming (Rs.)

| System of farming | 1985-86 | 1986-87 | 1987-88 | Percentage increase over 1985-86 in 1987-88 |
|---|---|---|---|---|
| Wetland | 7494 | 8658 | 9602 | 28.13 |
| I.D. land | 10043 | 12555 | 12540 | 24.86 |
| Dry land | 1737 | 2813 | 2475 | 42.49 |

Table 4 : Production pattern under pre-watershed and post - watershed (Qts.)

|  | Pre-watershed (1982-83) | Post-watershed (1987-88) | Percentage increase |
|---|---|---|---|
| Cereals | 8176 | 8799 | 107.62 |
| Oilseeds | 2230 | 5199 | 233.14 |
| Pulses | 30 | 226 | 753.33 |

Table 5 : Fertilizer consumption pattern (Kg/ha)

| Year | Nitrogen | Phosphorus |
|---|---|---|
| 1983-84 | 4.54 | 19.50 |
| 1988-89 | 9.04 | 36.00 |
| Percentage increase | 429.00 | 398.00 |

shown a satisfactory yield levels under mixed cropping programme.

Thus, the above discussion clearly purports that there are favourable yield variations between pre-and post watershed periods thus encouraging the farmers of the area to realize the importance of watershed management as it has directly helping them in increasing their incomes.

## Net income per hectare

This parameter ultimately explains the impact of wastershed management on the prosperity of the farmers and hence selected. The data presented in Table 3 reveals that there is a continuous increase in per hectare incomes of the farmers under wet and irrigated dry (ID) land conditions. The incomes are even more under ID conditions when compared to wet and dry land. The reason can be attributed that the farmers were encouraged to select those commercial crops that gives higher productivity under ID conditions. There is an increase of 42 per cent on per-hectare basis in incomes under dry land conditions in a three year period. This phenomenon is quite natural since the awareness on soil and water conservation importance among farming community has increased in the area, hence the per hectare incomes increased.

## Productivity pattern

The data on production pattern between the periods pre and post watershed programme (Table 4) indicated that there is an increase in the oilseeds production by 233 per cent and pulses by 753 per cent. Thus, it can be seen in Chinnatekur watershed area due importance to pulses and oilseeds production as these crops require irrigation facilities in intervals and the production achievement is in accordance with the agricultural production policy of the government.

## Fertilizer consumption

The data (Table 5) pertaining to fertilizer consumption for both nitrogen and phosphorus clearly explains that there is a tremendous increase in fertilizer consumption on per hectare basis. This is in accordance with the earlier results indication on land use and cropping pattern as they have changed tremendously because of additional irrigation facilities creation through watershed management and hence, called for higher doses of fertilization.

## Per-capita income

The records indicated an increase in the per capita income to Rs. 3246 from Rs. 1443 in absolute terms between the periods 1984-85 to 1987-88 with 125 per cent increase.

## Summary

1. There is a spectacular change in the land use pattern between pre-and post watershed periods.

2. Cropping intensity increased by 140 per cent under post-watershed period.

3. The dry-cum-wet area increased from a meager 12 to 129 hectares while dry - land area decreased by 200 hectares.

4. The yield potentialities on per hectare basis indicated a 100 per cent increase between pre- and post -watershed periods in almost all the crops.

5. The watershed management scheme brought in new farming systems i.e., mixed and relay cropping with the introduction of red gram.

6. There is a continuous increase in the per-hectare incomes and more so under ID and dry conditions.

7. There is a tremendous increase in pulses and oilseeds production.

8. There is a remarkable growth in the fertilizer consumption.

9. The per capita income indicated an increase between pre-and post watershed periods.

## Conclusion

Watershed programme has opened new vistas by exploiting and conserving the scarce resource i.e., water and brought major changes in the cropping pattern thereby generating employment opportunities mainly to the marginal and small farmers and enabling them to raise their incomes as well as standard of living. Thus, dry land agriculture will no longer gambles with monsoon, provided the watershed management programme are implemented in its letter and spirit.

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(Received on 17-03-2003 and revised on 31-10-2003)

*The Andhra Agric.* J. **50** (3&4) : 337 - 341, 2003

# Constraints Among Koyas in Adoption of Improved Dairy Farming Practices

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## ABSTRACT

The study was conducted in West Godavari Distrct of Andhra Pradesh in three Mandals in six villages. The results revealed communication gap between tribals and non-tribals. Most of the tribals are below poverty line because of ecological limitations, uneconomic and non-viable land holdings and with very low milk production from their cattle. There were serious constraints in adoption of improved dairy farming practies. The A. I. Center and Veterinary dispensaries were not utilized properly.

**Key words :** Constraints, Dairy Farming, Live Stock, Social Sciences.

Development programmes always emphasized the use of modern scientific technologies. No doubt, these technologies contribute to increase the farm productivity and augment the net profit. However, some of the improved technologies do not find place equally in all the locations because of variations in multifactor scenario. At the same time, they require costly inputs besides being complex to understand and practice by the small farmers (Mane and Sutaria, 1993). These people are deriving least benefit of the technologies because either the technologies are not relevant to them or they don't have access to the knowledge, technical input, services, etc. (Chambers et al., 1989; Rao, 1993). Many researchers in past have assessed the level of adoption of recommended practices and found it to be very low and have identified several socio-economic technological and institutional constraints affecting the adoption. But most of such works have covered non-tribal settings. Further, no concerted effort has been directed towards measuring the extent of adoption and constraints experienced by tribal settings. It is also argued that the adoption of modern technologies pertaining to Animal Husbandry need the infrastructural facilities such as Artificial Insemination centers, equipments, clinical facilities, technical services etc., which are not always available and accessible to all the livestock owners in the country (Rao, 1993). Most of the tribals in India were still below poverty line because of ecological limitations, uneconomic and non-viable land holdings and very low milk production from milch animals. Out of 33 Schedule Tribal groups of Andhra Pradesh, Koya is the predominant tribal group with unique culture concentrated in the boarder area of Khammam, East Godavari and West Godavari district of AP. With this background the present study was devoted to analyse the constraints as perceived by Koyas in adoption of improved dairy farming practices.

## METHODOLOGY

This study was conducted in purposively selected West Godavari district of coastal Andhra Pradesh. Out of 46 mandals of the district, 3 mandals (Jeelugumilli, Polavaram and

Buttayagudem) were purposely selected, where koyas are predominantly inhabitated. Two villages from each of selected 3 mandals i.e., total 6 villages (Bothappa Gudem, Puchika Padu, Kondrukota, Chilakaluru, Cheemalavari Gudem and Doramamidi) were selected. Fifteen farmers from each village i.e., total 90 farmers, 30 each from small, medium and large categories were selected on the basis of herd size.

The data were collected through an interview schedule on various aspects of study. The tribal farmers were individually interviewed and personal observations were also made. The data were analysed using statistical package for Social Sciences (SPSS).

Descriptive statistics (frequency tables, simple percentage) and simple ranking were used to analyse the data.

## RESULTS AND DISCUSSION

### Constraints as perceived by koyas in adoption of improved dairy farming practices

The dairy farmers have to adopt the scientific dairy innovations to increase milk production of his livestock. Though there are separate experts to handle different facets of dairy development, the rural milk producer has to take all the decisions concerning his herd. It is obvious by the slow progress with which dairy farming technology is getting diffused that there are variety of constraints being faced by the dairy farmers. Thus, a small part of this study was devoted to analyse the constraints as perceived by the farmers.

### 1. Lack of sufficient knowledge in different areas of improved dairy farming practices

About seventy eight per cent of the people were found to be lacking in sufficient knowledge in improved dairy farming practices. This situation can mainly be attributed to illiteracy and low family education status. Most of the tribals did not have any formal education. The level of social participation of tribals was also too low. The socio-economic status was also found to be too low to invite any changes in their day - to -day life.

Moreover the ethnographic setting of the tribal area too keeps them away from the civilized people of towns. There exists a lot of communication gap between tribals and non-tribals. Institutional and transport facilities were also not developed in that area. Folk beliefs associated with dairying and livestock production practices also make them reluctant to accept any new technologies.

### 2. Distant location of Artificial Insemination (AI) centre and veterinary hospital

Nearly seventy per cent of the respondents indicated towards this problem and it ranks 4th among the constraints in the adoption of improved dairy farming practices. The veterinary hospital and Artificial Insemination (AI) centers not within the reach of tribals as they are located at mandal headquarters and major panchayats. Due to lack of adequate transport facilities the tribals could not utilize them properly.

### 3. Non-availability of Veterinary Assistant Surgeon / Veterinary Inspector

About fifty seven per cent of the respondents pointed towards this as a major constraint and it is ranked 8th among all. The staff available at the veterinary hospitals and Artificial Insemination (AI) centers is less than requirement. It leads to many problems like communication gap between farmers and doctors. The doctors were found unable to cover entire area. Unavailability of doctors at all times and unplanned visits of doctors were other related constraints.

### 4. Non-availability of medicines

Nearly sixty per cent of the tribal farmers indicated this as a major constraint and it is ranked 7th among all. Tribals are compelled to buy medicines from private medical shops at far away towns. The tribals are not in a position to judge the correct medicines given to them.

### 5. Lack of good transportation facilities

It was indicated as a major problem by nearly sixty eight per cent of the total respondents and is ranked 5th. Road connection is lacking even among hamlets. Proper transactions do not take place between tribals and non-tribals due to lack of adequate transport facilities. It stands in the way of visits by government officials and development personnel from various organizations.

### 6. No co-ordination with other agencies for inputs availability and supply.

Nearly forty per cent of the respondents indicated this as a major constraint and is ranked 11th among all. Organizations like Integrated Tribal Development Agency (ITDA), International Fund for Agricultural Development (IFAD), Central government, State government and other non-governmental organizations lack coordination among themselves as to the supply of inputs to tribals. They have different strategies for their work which often overlap, resulting in non-availability of inputs on time.

### 7. Poor economic status and high cost of inputs

It was pointed out as a major problem by about 53 per cent of the total respondents and is ranked 9th among all about 29 per cent of the tribals have less than Rs. 4500 of annual income and about 50 per cent have an income ranging between of Rs. 4500 to Rs. 15000. Most of them are below poverty line. High cost of Balanced Concentrate Mixture (BCM) to animals is also a problem and poor knowledge of dairy farmers about the use and utilization of locally available concentrate feed.

### 8. Non existence of milk cooperatives in the village

Ninety three per cent of the respondents indicated this problem as a serious constraint and it is ranked 1st among all the major constraints. Not even a single hamlet has cooperative in this tribal setting. Lack of cooperatives has led to exploitation by middlemen. Poor transportation facilities obstruct the tribals to market directly in nearby towns.

### 9. Lack of interest on the part of Village Development Officer/Sarpanch for reporting outbreak of diseases

Nearly 37 per cent of the total respondents indicated this problem and it is ranked 13th among all the constraints. It may be attributed to lack of good leadership locally. It reveals that majority of the respondents were not getting any response from local veterinarian in case of outbreak of disease, whereas rest held VDO or Sarpanch responsible for not reporting outbreak of disease to concerned officials.

### 10. Lack of adequate extension facility

Nearly 47 per cent of the respondents indicated this problem and is ranked 10th among all constraints. Less emphasis is laid on practical demonstration. Training programmes are not provided in local dialects to tribal farmers, and the training standards are also not brought down to the level of understanding of tribals. Moreover the timings of training courses are also not properly adjusted. And the contents of training are not in accordance with the needs of tribals. There is also lack of experienced and field oriented staff.

Table 1 : Constraints as perceived by Koyas in adoption of improved dairy farming practices

| Sr. No. | Constraint | Frequency | Rank |
|---|---|---|---|
| 1. | Lack of sufficient knowledge in different areas of improved dairy farming practices | 71(78.81) | II |
| 2. | Distant location of A.I. centre and veterinary hospital | 63(69.93) | IV |
| 3. | Non-availability of VAS / VI | 52(57.72) | VIII |
| 4. | Non- availability of medicines | 54(59.92) | VII |
| 5. | Lack of good transportation facilities | 61(67.71) | V |
| 6. | No co-ordination with other agencies for inputs availability and supply | 36(39.96) | XI |
| 7. | Poor economic status and high cost of inputs | 48(53.28) | IX |
| 8. | Non existence of milk cooperatives in the village | 84(93.24) | I |
| 9. | Lack of interest on the part of VDO / Sarpanch for reporting outbreak of diseases | 33(36.63) | XIII |
| 10. | Lack of adequate extension facility | 42(46.62) | X |
| 11. | Exploitation by middleman | 64(71.04) | III |
| 12. | Unmanageable cost of maintenance of crossbreeds | 56(62.16) | VI |
| 13. | Lack of faith in modern medicines and veterinary staff and more faith in indigenous medicines and quacks | 34(37.74) | XII |

Figure in the parenthesis indicate percentage

### 11. Exploitation of middlemen

About 71 per cent of the respondents pointed out to this problem and is ranked 3rd among all constraints. Lack of cooperatives is the major reason for this problem. Middlemen exploit by all means - improper weighing, irregular payment of money, low payment etc.

### 12. Unmanageable cost of maintenance of crossbreeds

About 62 per cent of the respondents opined that this is the major constraint and it was ranked 6th among all major constraints. Most of the farmers are not in a position to maintain crossbreds owing to their low economic status and poor knowledge regarding maintenance of crossbreds.

### 13. Lack of faith in modern medicines and veterinary staff and more faith in indigenous medicines and quacks

Nearly 38 per cent of the respondents indicated this as a major problem and is ranked 12th among all the major constraints. Treatment of sick animals by veterinary staff was done by not more than 44 per cent of the respondents. For the remaining 56 per cent of dairy farmers, traditional treatment methods or consulting local quacks was the first and last resort to tackle the problem of sick animals. Non-availability of veterinary aid readily in the village, distant location of veterinary dispensary and exorbitant charges levied by veterinary staff for treating animals, have forced the farmers to lose faith in modern medicines. Moreover, it is a great privilege for tribals to employ traditional mode of treatment and traditional quacks.

### Recommendations

It was found that the ethnographic setting of the tribal area to keeps them away from the civilized people of towns. There exists a lot of communication gap between tribals and non-tribals. Institutional and transport facilities were also not developed in this area. Based on this study it is recommended that i) Most of the tribals were still below poverty line because of ecological limitations, uneconomic and non-viable land holdings, and very low milk production from their cattle. Hence, for each of these areas separate problem oriented strategy would have to be evolved both in agricultural and in allied sectors to supplement their low income. There is an urgent need to simplify the procedures to obtain the credit so as to enable tribals to utilize facilities extended by the formal credit sources more effectively, ii) It was found that there were serious constraints in adoption of improved dairy farming practices as perceived by tribal dairy farmers. Unless these constraints are mitigated by the administrators of ITDA and development personnel of other organisations involved in the development of the area, the extent of dairy development will not be smooth and effective, iii) The poor utilization of A.I. Center and veterinary dispensaries was not only a sequel of ignorance of farmer, but also due to poor availability of services and inputs as well as the distant locations of these infrastructure. There must be a veterinary subcentre for every 5 - 10 villages with the necessary provision of semen, medicines, vaccines and other inputs, and iv) Since majority of the tribals preffered natural service over A.I. at least one improved type of bull must be distributed for every 5-10 villages.

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(Received on 31-12-2001 and revised on 09-08-2002)

*The Andhra Agric. J.* **50** (3&4) : 342 - 344, 2003

# Knowledge and Rationality of Indigenous Farm Practices (IFP)

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## ABSTRACT

The study was conducted in Srikakulam and Vijayanagaram districts of Andhra Pradesh with 120 farmers as sample from eight selected villages of four mandals each District. The rational IFP has shown high level of knowledge compared to irrational IFP. The rational IFP was adopted from generation to generation and the concerned knowledge was retained in the communtity. This was true in paddy, mesta and pulses grown in the region. On the other hand knowledge on irrationl IFP decreased through generations because of lack of sientific evidence.

**Key words :** Indigenous Farm Practices, Food grain production.

India experienced four fold increase in food grain production from 1950 s to 1998 even though the available land area for cultivation had decreased. The soil and environment were got polluted due to injudicious land utilisation by the farming community with high intensity cropping and dumping of chemical and synthetic pesticides, fertilizers and growth promoters with a motive to get higher yields. At this juncture, there is a need to emphasize ecofriendly indigenous methods to achieve required food grain production keeping intact of environmental pollution in check.

## METHODOLOGY

The study was conducted in Srikakulam and Vizianagaram districts of north coastal zone of Andhra Pradesh to find out the different aspects of indigenous farm practices (IFP). A sample of 120 farmers was fixed considering the time and resources available to the student researcher. A list of farmers from the eight selected villages of four mandals from the two selected districts and respondents were selected using proportionate random sampling method. The scientific rationality behind the IFP was found out by referring the list of IFP to 30 Agricultural Scientists in the study area. Out of 96 IFP identified, 36 IFP were selected and used to test knowledge of farmers on IFP in the form of alternate / multiple choice questionnaire.

## RESULTS AND DISCUSSION

In general, rational IFP had shown high level of knowledge than that of irrational IFP. The rational IFP were adopted from generation to generation and that is why the knowledge on rational IFP was retained in community. On the other hand lack of scientific evidence had made the knowledge on irrational IFP decreasing through generations leading to low level of knowledge.

### IFP on General Agriculture

Among the 9 IFP except one all other practices were found rational. The rational IFP "Trees harbour birds and insects" had shown low knowledge. This was because of faith of farmers on trees which makes the atmosphere pollution free and less incidence of birds and insect pests due to growing of trees.

## Paddy

Among the 7 IFP related to paddy 5 were found rational and remaining two were irrational. The IFP "$2^{nd}$ week of August is the best time" for transplanting of paddy seedlings had shown high knowledge (85.00 of respondents) though it was not rational. This high knowledge might have been due to rationality of practice, age and time of transplantation of seedlings proved optimum.

## Mesta

All the 5 IFP were rated rational by the scientists and had shown high knowledge of farmers on these practices.

## Pulses

Among the three IFP, one was found irrational and had shown high level of knowledge (82.50% of respondents). The high knowledge on this practice might be due to the belief that more plant population yields more.

Table 1:

| Sl.No. | Knowledge Items | % | Rationality |
|---|---|---|---|
| **General Agriculture** | | | |
| 1. | Deep ploughing is essential for moisture conservation | 80.00 | R |
| 2. | Continuous drizzling leads to the occurrence of more number of pests. | 90.00 | R |
| 3. | Trees harbour birds and insects which damage food crops | 37.50 | R |
| 4. | Farmers collect enriched silt from dried reservoir beds and broadcast in their field during summer | 95.00 | R |
| 5. | Soil fertility is most important for crop growth rather than any farm practice | 90.00 | R |
| 6. | Deep sowing is important for rainfed agriculture | 72.50 | R |
| 7. | Farmers use a multi purpose tool hand hoe (Borigi) for sowing, harrowing, weeding, digging, interculture etc. | 80.00 | R |
| 8. | Providing irrigation whenever termite attack is observed | 90.00 | R |
| 9. | Killing of rats is a sin. This belief leads to non adoption of rat control practices. | 52.50 | IR |
| **Paddy** | | | |
| 10. | Sowing paddy during punara to ashlisha period gives higher crop yields | 82.50 | R |
| 11. | Transplantation of paddy seedlings into main field should be completed before 30 days of sowing | 85.00 | R |
| 12. | $2^{nd}$ week of August is the best time for transplantation of paddy seedlings into main field | 85.00 | IR |
| 13. | Alternate wetting and drying results in good rice crop | 42.50 | IR |
| 14. | Continuous rains during ear head emergency stage induces the incidence of brown planthopper in rice | 80.00 | R |
| 15. | Neem cake is applied as basal manure which helps to protect paddy crop from BPH and improves soil fertility | 80.00 | R |
| 16. | Up rooting gall midge affected seedlings and burning in the nursery before transplantation | 95.00 | R |
| **Mesta** | | | |
| 17. | Just 3 ploughings are sufficient for mesta cultivation | 75.00 | R |
| 18. | Farmers uses high seed rate to secure the expected yield even in case of drought as well as high rainfall | 67.50 | R |
| 19. | Mesta is sown as mixed crop with sesamum to compensate yield loss from one another | 57.50 | R |
| 20. | Deep ploughing is practiced before sowing mesta (during summer) so that microorganisms exposes to sunlight and dies | 87.50 | R |

| | | | |
|---|---|---|---|
| 21. | Farmers reduce mesta seed for next crop by keeping the part of the crop upto full maturity stage which is identified by brown colouration of pods. And the seeds are extracted after sun drying for 15-20 days. | 97.50 | |
| **Pulses** | | | |
| 22. | If there is humidity during November to January, aphid infestation in pulses will be very high | 80.00 | R |
| 23. | The dried pulses were well impregnated with oil and stored in closed container | 82.50 | R |
| 24. | High plant population in pulses given higher yields | 82.50 | IR |
| **Mango** | | | |
| 25. | Flowering in Mango should come before lasting December to fetch higher yields | 72.50 | R |
| 26. | Soil from dried tank bases is applied to improve soil fertility of garden land particularly in mango orchards | 95.00 | R |
| 27. | Gamaxin, commonly called as "Cheemala Mandu" (telugu) is used to apply at the trunk base to prevent ants problem in mango | 67.50 | R |
| **Sugarcane** | | | |
| 28. | Sugarcane is sown on ridges with a furrow width of 1 - 2 feet | 90.00 | R |
| 29. | There are two types of sugarcane crops are grown such as adsali (one and half year duration) and eksali (one year duration) | 90.00 | R |
| 30. | Trash mulching is practiced immediately after sowing of sugarcane to conserve soil moisture | 95.00 | R |
| 31. | If sugarcane is cultivated year after year the productivity goes down | 67.50 | R |
| 32. | Two years sugarcane and paddy rotation improves the yield of both the crops | 100.00 | R |
| **Groundnut** | | | |
| 33. | Farmers used to dibble groundnut seeds by walking behind the country plough furrow at 1 feet spacing approximately. The furrow closes automatically when the subsequent furrow opens by the plough | 95.00 | R |
| 34. | Gypsum is essential for groundnut crop | 97.50 | R |
| 35. | Rabi Groundnut gives higher yields than *kharif* Groundnut | 52.50 | R |
| 36. | Spreading varieties are believed to be best for dry lands | 82.50 | R |

## Mango, Sugarcane and Groundnut

All the IFP were found rational and had shown medium to high level of knowledge by the farmers.

## Conclusion

The rational IFP which had shown high level of knowledge can be easily disseminated by the extension agency for promotion of sustainable eco friendly agriculture. The knowledge on irrational IFP on the other hand effects negatively the transfer of technology. There is a responsibility on extension agency to discourage the farmers in adoption of such IFP so that the rational IFP can be promoted in blend with modern scientific technology.

(Received on 18-02-2001 and revised on 03-06-2002)

The Andhra Agric. J., 50 (3&4) : 345 - 347, 2003

# Poverty Alleviation Programmes and Their Impact on Tribal Development in Andhra Pradesh

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## ABSTRACT

There are 33 Scheduled tribes in Andhra Pradesh with a total population of 41.99 lakhs constituting 6.31 per cent of the State population as per 1991 census. Basing as areas of their habitation and level of development these tribal groups have been categorised into four sub groups. At the end of VIII Five Year Plan period (1992-1997) the total expenditure in tribal sub-plan areas in the state through different development programmes viz., ITDA, MADA, P.T.G. and DTG was Rs. 7890.93 lakhs. It is estimated that there are 8.40 lakh Scheduled Tribal families of which 6.72 lakhs are S.T. families living below the poverty line. Under Poverty Alleviation Programme, 3.70 lakh S.T. families were assisted upto the end of VIII Five year plan period. All the programmes the amount of expenditure as well as the number of families assisted were the highest in all the sectors under the ITDA Programme it self except of animal husbandry programmes.

**Key words :** Poverty Alleviation programmes, Tribal development.

The ITDP was initiated as an area development programme in the fifth plan period. But it was later realised by the government that it was not easy to identify and to concrete benefits to tribals alone and that it was quite likely that non-tribals would gain more than the tribals. Therefore, during the sixth plan, the tribal sub-plan (TSP) which guides and positions the ITDP tooks special note of this and converted the ITDP into a target group approach where individual families were selected to benefit concretely from the programme. Therefore different strategies are being adopted for tackling the problems of different tribal groups which should be area specific and group specific economic activities depending on the local demand.

## MATERIAL AND METHODS

The study was conducted in the state of Andhra Pradesh. Out of 23 districts, nine districts *viz.*, Srikakulam, Vizianagaram, Visakhapatnam, East Godavari, West Godavari, Khammam, Warangal, Adilabad and Mahaboobnagar districts were implemented Tribal sub-plan programme strategies. The above 9 ITDA's were selected purposively to study the impact of different developmental programmes for Poverty Alleviation Data was collected by using well structured and pretested schedule. The tabular analysis was used to drown meaningful conclusions.

## RESULTS AND DISCUSSION

The details of sectorwise expenditure and families assisted under different programmes in the State for the period 1992 - 93 to 1996-97 are presented in Table. It is observed that the total expenditure in tribal Sub-plan areas in the state was Rs. 7890.93 Lakhs and assisted nearly 370351 families. Out of this total amount the share of expenditure was maximum with Rs. 4735.90 Lakhs (60.01%) and assisted 250989 (67.77%) families under Integrated Tribal Development Agency (ITDA) Programme. The

Table : Sector wise expenditure incurred and families assisted under different programmes in the state for the period 1992-93 to 1996-97.

| Sl. No. | Sector | I.T.D.A |  | M.A.D.A |  | P.T.G. |  | D.T.G |  | Total |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Expenditure Rs/Lakhs | No. of families assisted | Expenditure Rs/Lakhs | No. of families assisted | Expenditure Rs/Lakhs | No. of families assisted | Expenditure Rs/Lakhs | No. of families assisted | Expenditure Rs/Lakhs | No. of families assisted |
| 1. | Agriculture | 572.60<br>(7.26) | 55436<br>(14.97) | 191.68<br>(2.43) | 5612<br>(1.52) | 268.79<br>(3.41) | 35194<br>(9.50) | 97.28<br>(1.23) | 3022<br>(0.82) | 1130.35<br>(14.33) | 99264<br>(26.81) |
| 2. | Minor Irrigation | 1464.38<br>(18.56) | 23839<br>(6.44) | 472.64<br>(5.99) | 8719<br>(2.36) | 155.27<br>(1.97) | 2130<br>(0.58) | 259.59<br>(3.29) | 3909<br>(1.05) | 2351.88<br>(29.81) | 38597<br>(10.43) |
| 3. | Animal Husbandry | 105.34<br>(1.33) | 2897<br>(0.78) | 127.66<br>(1.62) | 2872<br>(0.78) | 117.79<br>(1.49) | 1946<br>(0.53) | 60.63<br>(0.77) | 1452<br>(0.39) | 411.42<br>(5.21) | 9167<br>(2.48) |
| 4. | Horticulture | 1188.41<br>(15.06) | 124744<br>(33.68) | 49.20<br>(0.62) | 6099<br>(1.64) | 196.82<br>(2.49) | 11709<br>(3.16) | 47.18<br>(0.60) | 2821<br>(0.76) | 1481.61<br>(18.77) | 145373<br>(39.25) |
| 5. | Sericulture | 125.12<br>(1.59) | 5405<br>(1.46) | 13.16<br>(0.17) | 314<br>(0.08) | 23.57<br>(0.30) | 355<br>(0.10) | 2.13<br>(0.03) | 27<br>(0.007) | 163.98<br>(2.09) | 6101<br>(1.64) |
| 6. | Fisheries | 52.39<br>(0.66) | 2137<br>(0.58) | 10.0<br>(0.13) | 342<br>(0.09) | 7.94<br>(0.10) | 246<br>(0.07) | 1.68<br>(0.02) | -- | 72.01<br>(0.91) | 2725<br>(0.74) |
| 7. | I.S.B | 151.31<br>(1.91) | 5269<br>(1.42) | 103.89<br>(1.31) | 2526<br>(0.68) | 72.42<br>(0.92) | 4985<br>(1.34) | 139.16<br>(1.76) | 4288<br>(1.16) | 466.78<br>(5.91) | 17068<br>(4.60) |
| 8. | Others | 1076.35<br>(13.64) | 31262<br>(8.44) | 137.74<br>(1.75) | 2352<br>(0.64) | 287.15<br>(3.64) | 9651<br>(2.60) | 311.66<br>(3.95) | 8791<br>(12.37) | 1812.90<br>(22.97) | 52056<br>(14.05) |
|  | **TOTAL** | **4735.90**<br>**(60.01)** | **250989**<br>**(67.77)** | **1105.97**<br>**(14.02)** | **28836**<br>**(7.79)** | **1129.75**<br>**(14.32)** | **66216**<br>**(17.88)** | **919.31**<br>**(11.65)** | **24310**<br>**(6.56)** | **7890.93**<br>**(100)** | **370351**<br>**(100)** |

Figures in parantheses indicate Percentage to their respective Totals.

minor irrigation sector was given prime importance and the highest expenditure of Rs. 1464.38 Lakhs (18.56%) was incurred under ITDA, followed by Horticulture with Rs. 1188.41 Lakhs (15.06%) and the expenditure on Agriculture was Rs. 572.60 lakhs (7.26%) under other categories also a substantial amount of Rs. 1076.35 lakhs (13.64%) has been spent when the number of families assisted was considered, Horticulture sector covered 33.68 per cent of the total beneficiaries followed by Agriculture (14.97%), Minor Irrigation (6.44%). After the ITDA the highest expenditure was incurred under Primitive Tribal group programme (PTG) with Rs. 1129.75 lakhs (14.32%) followed by Modified area Development Approach (MADA) Rs. 1105.97 lakhs (14.02%) and Dispersed Tribal groups (DTG) with Rs. 919.31 lakhs (11.65%). The number of families assisted was highest in P.T.G. with 66216 (17.88%) followed by MADA 28836 (7.79%) and DTG 24310 (6.56%). Even when all these different programmes are considered, the sector wise expenditure and the number of families assisted were more in Horticulture, Minor Irrigation and Agriculture sector. The other sectors like Sericulture, Fisheries and Industries/ self employment / Business (I.S.B.) the expenditure as well as the number of beneficiaries share was minor.

Analysis has clearly indicated that of all the programmes, the amount of expenditure as well as the number of families assisted was highest in all the sectors for the ITDA programme it self except that of Animal Husbandry. After the ITDA the other programmes i.e., MADA, PTG and DTG were give almost equal importance and they have covered all the important sectors.

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(Received on 02-07-2002 and revised on 31-10-2003)

The Andhra Agric. J., 50 (3&4) : 348 - 352, 2003

# Cotton Production Practices - An Adoption Analysis

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## ABSTRACT

Cotton is cultivated in 33 million hectares in eighty countries and the average annual production is 19 million tonnes (1993 census). The study conducted in Guntur district of Andhra Pradesh state revealed that majority of the cotton farmers had medium level of adoption followed by high and low. Cent per cent of respondents have adopted the recommended practices of cotton cultivation in black cotton soils. Practicing canal irrigation and hand/mechanical weeding. None of the respondent farmers adopted the practices of cotton cultivation in red soils / alluvium soils, delinting of seeds, tanks, wells and tube well irrigations, synchronized planting, yellow sticky trap, introduction of bio control agents and application of Helio NPV.

**Key words :** Cotton Production, Adoption, Commercial crop.

The current status of cotton production and consumption pattern shows that India has major strides since independence from net importer to self sufficiency and a marginal exporter of raw cotton. In India, cotton is cultivated in 9 million hectares across the nine major states and with a production of 12.20 million bales (each bale 170 kg) in 1998-99. To tide over the imbalance in supply and demand. Compaigns like "Grow More Cotton" and Cotton Extension Schemes Focussing on area expansion were launched in the early 50s. Emphasis to raise productivity was made by formulating 'package programme'. The intensive cotton development programme was launched in 1971 - 72. The main objective was to improve production and productivity of cotton to meet the rising raw cotton demand of the textile industry.

Cotton is the major commericial crop in the state with an area of about 12.71 lakh hectares with a production of 15.33 lakh tonnes. The state ranks 3rd in area and production while in productivity it stands 5th in the country. The low productivity in the state is mainly due to coverage of major area under rainfed conditions with traditional varieties and neglected by management. With this view the adoption of recommended production practices of cotton were measured.

## METHODOLOGY

Exploratory research design was followed. Two mandals of Guntur district of Andhra Pradesh were selected purposively for drawing the 110 samples of the study. From each mandal three villages were selected randomly. The data were collected by personal interview with the help of structured interview schedule.

### Statistical Tools Used

Frequency and percentages were used to know the distribution pattern of respondents with respect to selected variables.

Percentages were used for standardization of size by calculating the number of individuals that would be a given category if the total number of cases were 100. Equal class interval. The variables selected for the study were grouped into different categories based on the equal class intervals of the total score i.e., the difference between minimum and maximum possible score divided by number of categories with respect to the selected variables.

## RESULTS AND DISCUSSION

Cotton Farmers were categorized in accordance with the extent of adoption of recommended packages of practices and presented in the Table 1 by following the equal class interval method.

Table 1 : Distribution of respondents regarding extent of adoption of recommended practices of cotton cultivation based on equal class interval (n = 110)

| Category | Frequency | Percentage |
|---|---|---|
| Low (0-17) | 12 | 10.90 |
| Medium (18 - 35) | 53 | 48.18 |
| High (36 - 53) | 45 | 40.92 |
| Total | 110 | 100.00 |

The data incorporated in Table 1 depicted that sizable number (48.18%) of the respondents had medium level of adoption. Whereas, 40-92 and 10-90 per cent of the respondents had high and low level of adoption respectively. This implies that the extent of adoption varied from farmer to farmer. This draws the attention of medium adopter category and make them to adopt the recommended practices of cotton cultivation. The finding was in line with the findings of Rogers (1995). The reason for varied extent of adoption could also be attributed to the individual differences in their sense perceptions. Since the adoption is a mental process through which an individual farmer passes from first stage of hearing about cotton cultivation to the adoption of cotton practices.

From Table 2 it was evident that cent per cent of the respondents have adopted the recommended practices of cotton cultivated in black cotton soils, practicing canal irrigation, hand / mechanical weeding and picking of cotton. These methods involve lesser skill, low cost with overwhelming profits.

Majority of the respondents (75-90%) adopted the recommended practices of ploughing with bullock drawn mould board plough, variety selection, application of chemical fertilizers, thinning and gap filling. Jassid control, white fly control, trap cropping with castor / okra, mechanical control of pests (hand pickings), botanical pesticides (neem oil, sesamum oil), red leaf control, bud and boll shedding control, bacterial blight control, removal of top leaves by topping in cotton plants, grading, storage and marketing of cotton.

The respondents (50-74%) adopted the following recommended practices in the order of ploughing with country plough, season, seed rate, seed treatment with concentrated $H_2SO_4$, Application of manure (FYM / cakes), Boll worm complex control, guard cropping with maize / jowar, ash (or) cow dung application, collection and destruction of affected plant parts and recommended crop period for harvesting.

The respondent (25-49%) farmers adopted the following recommended practices like ploughing with tractor drawn mould board plough, deep summer ploughing, optimum spacing for sowing, alternate furrow irrigation,

Table 2 : Item response analysis of extent of adoption of recommended practices of cotton cultivation. (n = 110)

| S.No. | Item | Confirmed to adopt | | Not Confirmed to adopt | |
|---|---|---|---|---|---|
| | | F | % | F | % |
| I. | Soils | | | | |
| | a) Black cotton soils | 110 | 100.00 | 0 | 0 |
| | b) Red soils | 0 | 0 | 110 | 100.00 |
| | c) Alluvium soils | 0 | 0 | 110 | 100.00 |
| II. | Land preparation | | | | |
| | a) Ploughing with country plough | 75 | 68.18 | 35 | 31.82 |
| | b) Bullock drawn mould board plough | 88 | 80 | 22 | 20.00 |
| | c) Tractor drawn mould board plough | 36 | 32.72 | 74 | 67.28 |
| | d) Deep summer ploughing | 32 | 29.09 | 78 | 70.91 |
| | e) Levelling | 15 | 13.63 | 95 | 86.37 |
| III. | Seeds and sowing | | | | |
| | a) Variety selection | 90 | 81.81 | 20 | 18.19 |
| | b) Season | 82 | 74.54 | 28 | 25.46 |
| | c) Seed rate | 59 | 53.63 | 51 | 46.37 |
| | d) Seed treatment with concentrated $H_2SO_4$ | 66 | 60.00 | 44 | 40.00 |
| IV. | Manures and fertilisers | | | | |
| | a) Application of chemical fertilisers | 85 | 77.27 | 25 | 22.13 |
| | b) Application of manures (FYM / Cakes) | 64 | 58.18 | 46 | 41.82 |
| V. | Irrigation | | | | |
| | a) Irrigation sources | | | | |
| | 1. Canals | 110 | 100.00 | 0 | 0 |
| | 2. Tanks | 0 | 0 | 110 | 100.00 |
| | 3. Tube wells | 0 | 0 | 110 | 100.00 |
| | 4. Wells | 0 | 0 | 110 | 100.00 |
| | b) Alternate furrow irrigation | 34 | 30.90 | 76 | 69.10 |
| | c) Number of times irrigated | 45 | 40.90 | 65 | 59.10 |
| VI. | Inter cultural operations | | | | |
| | a) Thinning and gap filling | 86 | 78.18 | 24 | 21.82 |
| | b) Synchronised planting | 0 | 0 | 110 | 100.00 |
| | c) Hand / mechanical weeding | 110 | 100.00 | 0 | 0 |
| | d) Herbicide usage | 33 | 30.00 | 77 | 70.00 |
| VII. | Inspect pest management | | | | |
| | a) Jassid control | 87 | 79.09 | 23 | 20.91 |
| | b) Whitefly - control | 95 | 86.36 | 15 | 13.64 |

| | | | | | |
|---|---|---|---|---|---|
| | c) Boll-worm complex control | 80 | 72.72 | 30 | 27.28 |
| VIII. | Integrated pest management (IPM) | | | | |
| | a) Trap cropping with castor / okra | 89 | 80.90 | 21 | 19.10 |
| | b) Guard cropping with maize / jowar | 79 | 71.81 | 31 | 28.19 |
| | c) Mechanical control of pests (Hand picking) | 79 | 71.81 | 31 | 28.19 |
| | d) Pheromone trap | 38 | 34.54 | 72 | 65.46 |
| | e) Yellow sticky trap | 0 | 0 | 110 | 100.00 |
| | f) Introduction of bio-control agents | 0 | 0 | 110 | 100.00 |
| | g) Botanical pesticides (neem oil, sesamum oil) | 91 | 82.72 | 19 | 17.28 |
| | h) Ash (or) cowdung application | 60 | 54.54 | 50 | 45.46 |
| | i) Crop rotation with chillies / jowar / maize / soybean / pulses / sesamum / redgram | 43 | 39.09 | 67 | 60.91 |
| | j) Inter cropping with cow pea / groundnut / greengram / soybean / clusterbean | 40 | 36.36 | 70 | 63.64 |
| IX. | Disease management | | | | |
| | a) Red leaf control | 98 | 89.09 | 12 | 10.91 |
| | b) Bud and boll shedding control | 83 | 75.45 | 27 | 24.55 |
| | c) Bacterial blight control | 88 | 80.00 | 22 | 20.00 |
| | d) Control of leaf spots like *Alternaria / cercospra / Helminthosporium* | 23 | 20.90 | 87 | 79.10 |
| X. | General management practice | | | | |
| | a) Removal of top leaves | 85 | 77.27 | 25 | 22.73 |
| | b) Application of Helio NPV @ 500 lt/ha or Bt formulation or neem seed kernal extract | 0 | 0 | 110 | 100.00 |
| | c) Conservation of natural enemies | 10 | 9.09 | 100 | 90.91 |
| | d) Collection and destruction of affected plant parts | 63 | 57.27 | 47 | 42.73 |
| XI. | Harvesting and yield | | | | |
| | a) Recommended crop period for harvesting | 76 | 69.09 | 34 | 30.91 |
| | b) Picking | 110 | 100.00 | 0 | 0 |
| XII. | Post harvest management | | | | |
| | a) Grading | 99 | 90.00 | 11 | 10.00 |
| | b) Storage | 102 | 92.72 | 8 | 7.28 |
| | c) Marketing | 105 | 95.45 | 5 | 4.55 |
| | d) Value addition | 23 | 20.90 | 87 | 79.1 |

F = Freuency; % = Percentage

Note : Response from cotton farmers were elicited on innovation - decision process (ID Process) continuum consisting of different stages like knowledge, persuasion, decision and confirmation either to adopt or not to adopt. Hence it is indicated in table 2 "Confirmed to adopt" as adopted or " Not confirmed to adopt" as non-adoption.

number of times irrigated, herbicide usage. Pheromone trap, crop rotation with chillies / jowar / maize / soybean / pulses / sesamum / redgram and intercropping with cowpea / groundnut / greengram / soybean / cluster bean.

Less than 25 per cent of the cotton farmers adopted levelling, control of leaf spots like *Alternaria / Cercospora / Helminthosporium*, conservation of natural enemies and value added products.

None of the respondent farmers cultivated in red soils and alluvium soils because the farmers under study were having only black cotton soils. Delinting of seed cannot be adopted by the respondents due to lack of knowledge, even though they have knowledge, they back foot that practice due to financial difficulty. Farmers do not go for tanks, tube wells, well type of irrigation. Since the study area Prattipadu and Pedanandipadu practice canal type of irrigation leaving tank, tube well and well type of irrigation.

None of the farmers adopted synchronized planting due to their beliefs and traditional is on. In fact, the farmers were not having the time to sow the crop on the same day. Further no respondent cotton farmer adopted yellow sticky trap due to lack of awareness and knowledge about the cultural methods. They opted chemical control of pests. Of course, none were introduced the bio control agents due to lack of confidence about biological control as it takes time for control of pests.

The practices of application of Helio NPV 500 lt/ha or Bt formulation or neem seed kernel extract for control of *Helicoverpa* was not adopted by cotton farmers due to lack of awareness and knowledge on this specific practice. Similar results were also recorded by Bhaskara Rao (1991) in hybrid cotton cultivation. Further, the findings were in confirmity with the reasons attributed by him. However, the findings are not in confirmity with the research findings of Adam (1994).

## Conclusion

The results of the study showed that the majority of the respondent cotton farmers had medium level of adoption followed by high and low. Cent per cent of the respondents have adopted the recommended practices of cotton cultivated in black cotton soils. Practicing canal irrigation, hand / mechanical weeding and picking of cotton. None of the respondent farmers adopted the practices of cotton cultivated in red soils / alluvium soils, delinting of seeds, tanks, well irrigation and tube wells, synchronized planting, yellow sticky trap, introduction of bio control agents and application of Helio NPV @ 500 lt/ha or Bt formulation or neem seed kernel extract.

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(Received on 10-08-2001 and revised on 12-09-2002)

The Andhra Agric. J., 50 (3&4) : 353 - 354, 2003

## Research Note

# Response of Sunflower (*Helianthus annus.* L) to Levels of Irrigation and Nitrogen

**Key words :** Sunflower, Irrigation, Oil seedcrop and Nitrogen.

Sunflower was given impetus in India and it has established as one of the important oil seed crops in Southern status because of its good inherent characteristics such as short duration, wider adaptability and good quality Oil. It is needless to emphasize, water is limiting and costly input in post - rainy season and hence, its judicious application needs special attention for maximising sunflower crop yield per unit of applied water.

To provide an objective means of fixing the time and depth of irrigation basing on water needs which primarily vary with evaporative demand, the concept of climatological approach was emphasized (Prihar *et al.*, 1976). Optimising the fertilizer application is equally important to stepup sunflower productivity. Nitrogen management assumes added importance in sunflower production due to its higher growth rate and dry matter production (Rao *et al.*, 1973).

A field experiment was conducted at Agricultural College Farm, Bapatla on clay soil during *rabi*. The treatments consisted of three irrigated regimes ($I_1$ irrigation at 0, 40 IW / CPE ratio, $I_2$ irrigation at 0.60 IW/CPE ratio and $I_3$ irrigation at 0.80 IW / CPE ratio) and four levels of nitrogen (0, 40, 80, and 120 kg ha$^{-1}$). The experiment was laid out in split plot design, replicated thrice, assigning irrigation treatments to the main plots and nitrogen levels to sub plots. The test variety was "Morden".

Data on head weight (g) as influenced by irrigation and nitrogen levels are presented in Table 1. Maximum head weight was recovered in the crop irrigated at 0.8 IW/CPE ratio compared to 0.6 and 0.4 IW/CPE ratios. Lowest head weight was recorded with 0.4 IW/CPE ratio. Nitrogen levels significantly influenced the head weight. Interaction between irrigaion and nitrogen levels was not significant. However, heads of sunflower were obtained with 120 kg N ha$^{-1}$compared to control 40 kg and 80 kg N ha$^{-1}$. The increase in head weight may be the resultant of improvement in head diameter. The factor which contributed might have also enhanced the head weight of sunflower. The findings were also supported by Sarah *et al.* (1992).

Seed yield was significantly varied by nitrogen levels and irrigation frequencies. However, the interaction effects were found to be non significant. The sunflower seed yield was significantly higher when the crop received irrigation at 0.8 IW/CPE ratio. The lowest seed yield was recorded when irrigated at 0.4 IW / CPE ratio.

Among nitrogen levels $N_3$ treatment i.e. 120 Kg N ha$^{-1}$ produced highest seed yield compared to $N_0$, $N_1$ and $N_2$ treatments. There was a progressive and significant increase in the

Table 1 : Head weight (kg ha$^{-1}$) Head diameter (cm) and seed yield (kg ha$^{-1}$) as influenced by levels of irrigation and nitrogen.

| Treatment | Head weight (kg ha$^{-1}$) | Head diameter (cm) | Seed yield (kg ha$^{-1}$) |
|---|---|---|---|
| IRRIGATION LEVELS | | | |
| I$_1$ (0.4 IW/CPE ratio) | 925.3 | 10.1 | 465.5 |
| I$_2$ (0.6 IW/CPE ratio) | 1183.8 | 11.7 | 605.0 |
| I$_3$ (0.8 IW/CPE ratio) | 1445.1 | 13.4 | 721.3 |
| SEm ± | 64.1 | 0.4 | 28.9 |
| C.D (0.05) | 251.7 | 1.4 | 113.6 |
| NITROGEN LEVEL | | | |
| N$_0$ (0.0 kg N ha$^{-1}$) | 667.0 | 9.3 | 331.4 |
| N$_1$ (40 kg N ha$^{-1}$) | 1088.7 | 11.5 | 543.7 |
| N$_2$ (80 kg N ha$^{-1}$) | 1406.3 | 12.5 | 715.4 |
| N$_3$ (120 kg N ha$^{-1}$) | 576.9 | 13.5 | 798.4 |
| SEm ± | 79.9 | 0.3 | 27.6 |
| C.D. (0.05) | 137.3 | 0.9 | 81.9 |
| IRRIGATION X NITROGEN INTERACTION | | | |
| A. SEm ± | NS | NS | NS |
| C.D. (0.05) | 138.3 | 0.5 | 47.7 |
| B. SEm ± | NS | NS | NS |
| C.D. (0.05) | 135.9 | 0.6 | 50.5 |
| C.V. % | - | - | - |
| | 12.1 | 16.1 | 14.4 |

A - Between nitrogen levels at the same level of irrigation.

B - Between irrigation levels at the same / different levels of nitrogen.

seed yield with each increment in nitrogen level from control to 120 kg N ha$^{-1}$. The increase due to 120 kg N was 140.9, 46.8 and 11.6 percent over control, 40 and 80 kg N ha$^{-1}$ respectively. The differences in seed yield recorded for N$_0$ and N$_1$; N$_1$ and N$_2$; N$_2$ and N$_3$ were significant.

Combinations of 0.8 IW / CPE ratio at 120 Kg N ha$^{-1}$ was found to be superior to rest of the treatment combinations.

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(Received on 21-05-2002 and revised on 06-08-2003)

The Andhra Agric. J., 50 (3&4) : 355 - 356, 2003

# Research Note

## Seed Yield of Green Manure Crops as Affected by Seeding Density and Phosphorus Application

**Key words :** Green Manure Crops, Seeding Density.

Green manuring is one of the most effective as well as environmentally sound methods of sustaining soil productivity in Agriculture. Green manures are mostly grown for the production of biomass which is normally incorporated at the time of flowering. Hence, there should be enough buffer stock of seeds in order to meet the seasonal production of green manures. The availability of adequate amount of good quality seed is a severe constraint for farming community to go in for the practice of green manuring. Production of seeds by green manure crops, is affected by several factors such as seeding density and soil fertility status, especially phosphorus availability. Hence, a field study was undertaken to evaluate three green manure crops *viz.*, sunnhemp (*Crotalaria juncea* L.), dhaincha (*Sesbania aculeata* L. *pers*) and pillipesara (*Phaseolus trilobus* L.) for their seed production under varied seeding densities and phosphorus levels.

The present study was laid out during *rabi* season of 2001 - 2002 in a randomized block design following the factorial concept with 27 treatment combinations comprising of three levels each of green manure crops (sunnhemp, dhaincha, pillipesara), seeding densities (25, 50, 75 kg ha$^{-1}$) and phosphorus levels (0, 30, 60 kg $P_2O_5$ ha$^{-1}$) and replicated thrice. It was conducted in Agricultural College Farm, Acarya N G Ranga Agricultural University, Bapatla. Soil of the experimental field was clay loam with pH 8.10, E.C. 1.10 dsm$^{-1}$, 0.4 per cent organic carbon, 211 kg available N ha$^{-1}$, 14 kg available $P_2O_5$ ha$^{-1}$ and 580 kg available $K_2O$ ha$^{-1}$. A common starter dose of nitrogen of 10 kg ha$^{-1}$ was applied uniformly to all the plots.

Among the green manure crops, sunnhemp produced the highest seed yield of 987 kg ha$^{-1}$ followed by dhaincha (666 kg ha$^{-1}$) and pillipesara (391 kg ha$^{-1}$) (Table 1). Plant density has a greater influence on seed producing ability of green manure crops. Reducing the seeding density from 75 kg ha$^{-1}$ to 25 kg ha$^{-1}$ significantly increased the seed yield in all the three crops. The lowest seed yield recorded with highest plant density could be due to the intense inter and intra plant competition for resources quite early in the reproductive period, which might have reduced the production of flowers or might have caused flower abortion. Similar results were reported with *Sesbania* sps. (Rengalakshmi and Purshothaman, 1999) and with velvet beans, sunnhemp and pillipesara at Coimbatore (Thomos and Palaniappan, 1998). The highest seed yield was obtained with 60 kg $P_2O_5$ ha$^{-1}$ which was significantly superior to that with 30 kg $P_2O_5$ ha$^{-1}$ or without phosphorus application. Higher level of phosphorus (60 kg $P_2O_5$ ha$^{-1}$) augmented the improvement in biomass production. Further, higher level of P might have also increased the seed setting percentage by decreasing flower abortion. In all the three crops, the combination of the lowest seeding density (25 kg ha$^{-1}$) and highest P application (60 kg $P_2O_5$ ha$^{-1}$) produced maximum seed yield than that of the other combinations. At this combination, the maximum seed yield by different green manure crops followed in the order of sunnhemp > dhaincha > pillipesara.

It can be concluded that the lowest level of seeding density (25 kg ha$^{-1}$) and the highest level of Phosphorus application (60 kg $P_2O_5$ ha$^{-1}$) recorded maximum seed yield in all the three green manure crops. At this combination, the maximum seed yield by different green manure crops followed the order, sunnhemp > dhaincha > pillipesara.

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Table 1 : Seed yield (kg ha$^{-1}$) of green manure crops as affected by seeding density and phosphorus levels

| Density (kg ha$^{-1}$) \ Phosphorus level kg $P_2O_5$ ha$^{-1}$ | Green Manure Crops | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sunhemp | | | Mean | Dhaincha | | | Mean | Pillipesara | | | Mean |
| | 0 | 30 | 60 | | 0 | 30 | 60 | | 0 | 30 | 60 | |
| 25 | 1008 | 1107 | 1191 | 1102 | 675 | 771 | 852 | 766 | 400 | 504 | 593 | 499 |
| 50 | 899 | 999 | 1085 | 994 | 582 | 679 | 762 | 674 | 299 | 404 | 494 | 399 |
| 75 | 767 | 869 | 956 | 864 | 465 | 564 | 649 | 559 | 175 | 282 | 373 | 277 |
| Mean | 891 | 992 | 1077 | 987 | 574 | 671 | 754 | 666 | 291 | 397 | 487 | 392 |

| | 'F' test | SEm ± | CD (P = 0.05) |
|---|---|---|---|
| Main effects : | Sig. | 16.5 | 46 |
| Two factor interaction : | Sig. | 29.0 | 80 |
| Three factor interaction : | NS | - | - |

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(Received on 12-10-2002 and revised on 06-08-2003)

The Andhra Agric. J., 50 (3&4) : 357 - 359, 2003

# Research Note

# Economics of Sunflower

**Key words :** Economics, Sunflower, Paddy Sugarcane.

Sunflower has vast scope to enter in South Gujarat where paddy-sugarcane is the most common cropping sequence followed, and also proved that the system is neither sustainable nor equitable because both the crops require large quantities of water which ultimately leading to secondary salinization with rising water table due to inefficient use of water, on one hand, more vulnerable to the incidence of pest and diseases, on the other hand. Therefore, the need to develop its production technology to augment the crop yield was realised, particularly regarding water and fertility management, the two major monitoring inputs. Further, looking on its cost and economic condition of an average farmer, the present investigation was undertaken to ascertain optimum schedule of irrigation, nitrogen and phosphorus with the sole objective of their economic viability.

Field investigations were undertaken during the rabi seasons of 1993 - 94 and 1994 - 95 at College Farm, Navsari. The experiment was laid out in a split plot design with three replications, having irrigation levels (0.6, 0.8 and 1.0 IW / CPE ratios) as main plot treatments and nitrogen (60, 80 and 100 kg/ha) and phosphorus (30.40 and 50 kg /ha) as sub plots. The soil of experimental plot was clayey in texture, having pH 7.9, E.C. 0.19 dsm$^{-2}$, 0.53% organic carbon, 31 kg/ha available phosphorus and 360 kg/ha available potash. Sunflower variety EC - 68414 was sown on 26th Nov., 1993 and 28th Nov., 1994 at 60 x 20 cm and was harvested on 16th March, 1994 and 15th March, 1995, respectively.

Incremental benefit was worked out from the data on additional yield of seed and stover obtained by each incremental level of treatments over the lower doses, considering prevailing market price. The incremental cost of each level of treatment was determined by considering the prevailing rate of irrigation, nitrogen and phosphorus. Net ICBR was computed by dividing incremental benefit with incremental cost and Rs. 1.00 was deducted for each level of treatments applied to work out net ICBR.

Data pertaining to economics, based on pooled analysis of 1993 - 94 and 1994 - 95 (Table 1) revealed that the maximum net realisation of Rs. 13, 011 / ha was obtained with IW/CPE of 0.8 which received 6 irrigations in total (including two common irrigations), with the cost benefit ratio of 1 : 2.47 followed by IW/CPE ratio 1 (seven irrigations) and 0.6 ratio (five irrigations). The lowest net return was realised when the cost of produce was lowest and that of water was highest, whereas the highest net profit was observed when

Table 1 : Effect of irrigation, nitrogen and phosphorus levels on economics of sunflower (Pooled data of 1993 - 94 and 1994 - 95).

| Treatments | Seed yield (kg/ha) | Stover yield (kg/ha) | Gross return (Rs/ha) | Total No. of irrigations (including two common irrigations) | Cost of cultivation (Rs/ha) | Net return (Rs/ha) | Cost benefit ratio | Net ICBR |
|---|---|---|---|---|---|---|---|---|
| IW/CPE ratio | | | | | | | | |
| 0.6 | 1722 | 5047 | 18225 | 5 (300) | 8662 | 9563 | 1 : 2.10 | - |
| 0.8 | 2129 | 5833 | 21873 | 6 (360) | 8862 | 13011 | 1 : 2.47 | 1 : 17.24 |
| 1.0 | 2141 | 6016 | 22012 | 7 (420) | 9062 | 12950 | 1 : 2.43 | 1 : 8.47 |
| C.D. at 5% | 91 | 233 | - | - | - | - | - | - |
| Nitrogen (kg/ha) | | | | | | | | |
| 60 | 1868 | 5255 | 19205 | | 8734 | 10471 | 1 : 2.20 | - |
| 80 | 2070 | 5775 | 21277 | | 8862 | 12415 | 1 : 2.40 | 1 : 15.19 |
| 100 | 2104 | 5865 | 21626 | | 8990 | 12636 | 1 : 2.40 | 1 : 8.46 |
| C.D. at 5% | 65 | 166 | - | - | - | - | - | - |
| Phosphorus (kg/ha) | | | | | | | | |
| 30 | 1993 | 5601 | 20490 | | 8724 | 11766 | 1 : 2.35 | - |
| 40 | 2016 | 5639 | 20724 | | 8862 | 11862 | 1 : 2.34 | 1 : 0.70 |
| 50 | 2033 | 5655 | 20895 | | 8999 | 11896 | 1 : 2.32 | 1 : 0.47 |
| C.D. at 5% | NS | NS | - | - | - | - | - | - |
| Interactions | NS | I x N | - | - | - | - | - | - |

Figures in parenthesis indicate total quantity of water applied (ha mm)

Cost of each irrigation : Rs. 200 /ha Cost of nitrogen : Rs. 6-40/kg Cost of phosphorus : Rs. 13-75 /kg

Rate of sunflower seed : Rs. 1,000/q Rate of stover : Rs. 10 / q the cost of irrigation was lowest and that of sunflower was highest. The findings are in agreement with the reports of Pawar *et al.* (1993).

The maximum net return was realised with 100 kg N/ha which was clearly indicated by cost benefit ratio 1 : 2.4. The results are substantiated with the reports of Salam *et al.* (1978). Phosphorus fertilization did not increase net realization to a considerable extent even at higher doses. The cost benefit ratio decreased slightly with increase in phosphorus levels which clearly indicated that phosphorus fertilization showed no beneficial effect on economic harvest of sunflower. Similar findings were also reported by Singh and Pacharia (1981).

### Incremental Cost Benefit Ratio

The highest net ICBR was obtained with IW/CPE ratio of 0.8 (1 : 17.24) followed by 1 ratio (1 : 8.47). Similarly nitrogen dose of 80 kg N/ha recorded the highest net ICBR of 1 : 15 . 19 followed by 100 kg N/ha with 1 : 8.46 (Table 1). Net ICBR obtained with various levels of phosphorus did not attain to a minimum expected level of 1 : 1.

Therefore, it is concluded that sunflower accrued good economic returns at 0.8 ratio with 80 kg N/ha under South Gujarat conditions where the soils are low in nitrogen and medium in available phosphorus.

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(Received on 01-07-2002 and revised on 02-12-2002)

The Andhra Agric. J., 50 (3&4) : 360 - 362, 2003

## Research Note

# Effect of Sequential Application of Herbicides on Nutrient Uptake by Rice - Fallow Blackgram (*Vigna mungo* (L.) Hepper) and Associated Weeds

**Key words :** Sequential Application, Herbicides, Rice and Fallow.

Blackgram cultivation as a relay crop in rice-fallows is an unique system, wherein, sprouted seeds of blackgram are broadcasted in the standing paddy crop 2 to 3 days prior to its harvest. The blackgram sown in this system survives entirely on residual moisture and fertility. As there is no field preparation for sowing, the unchecked weed growth effectively competes with the crop for residual moisture, nutrients and reduce yield to the extent of 53 percent (Appanna, 1994). The weeds provide keener competition for nutrients and take away considerable share of nutrients and ultimately limiting crop - growth and yield. The information available on nutrient uptake by rice fallow blackgram and its associated weeds is very much meagre. Keeping this in view, the present investigation was under taken.

A field experiment was conducted during rabi 1994 -95 at Agricultural College Farm, Bapatla (A.P.). The experiment consisted of ten treatments (Table 1) was laid out in a randomized block design with three replications. The soil of the experimental field was sandy clay with $p^H$ 8.0 and was low in available nitrogen (250 Kgha$^{-1}$) and high in available P (31 Kgha$^{-1}$) and K (800 Kgha$^{-1}$). The sprouted seeds of blackgram (Cv. LBG - 17) were broadcasted in the standing paddy crop three days before its harvest. Sand-mix application of benthiocarb and pendimethalin were done at 7 DAS (day after sowing) immediately followed by (f.b.) water spray in order to provide sufficient moisture for herbicide absorption. The post emergence herbicides were applied at 20 DAS using a spray volume of 500 l ha$^{-1}$. The crop didn't receive any irrigation and fertilizer and survived entirely on residual moisture and fertility only. Where as, the preceding rice crop recieved a fertilizer dose of 120 : 60 : 60 Kg ha$^{-1}$ of N,$P_2O_5$ and $K_2O$, respectively. The gross and net plot sizes were 9x4 m and 6.5 x 3 m, respectively. At harvest the N,P and K content of weeds and crop were estimated by micro kjeldahl, vanadomolybdo phosphoric yellow colour and flame photometer methods, respectively (Jackson, 1973). The nutrient uptake by crop and weeds was worked out on the basis of concentration of these nutrients in total dry matter of weeds and seed and haulm yield of crop.

Weed flora of the experimental field consisted of *Panicum xylopodium* Trin. Var. Coloratum, *Echinochloa colonum* Link, *Cyperus rotundus* L. *Grangea maderaspatensis* Poir, *Chrozophora rottleri* klotzsch, *Lippia nodiflora* Mich, *Heliotropium ovalifolium* forsk and *Ludwigia parviflora* Roxb.

All the herbicidal treatments significantly influenced dry matter accumulation and nutrient

Table 1 : Effect of pre and post emergence herbicides on dry matter accumulation and nutrient uptake by rice fallow blackgram and its associated weeds at harvest

| Treatment | Rate (Kgha$^{-1}$) | Time of application (DAS) | Total weed dry matter at harvest (gm$^2$) | Nutrient depletion by weeds (kg ha$^{-1}$) at harvest | | | Crop dry matter at harvest (gm$^2$) | Seed yield (Kgha$^{-1}$) | Nutrient uptake by crop (kg ha$^{-1}$) at harvest | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Nitrogen | Phos - phorus | Pota - ssum | | | Nitrogen | Phos - porous | Pota - ssium |
| Unweeded Check | -- | -- | 15.51<br>(240.00) | 31.30 | 7.29 | 29.88 | 72.45 | 192.00 | 15.21 | 2.75 | 12.85 |
| Hand weeding twice | -- | 20 & 40 | 6.92<br>(47.33) | 3.27 | 1.24 | 6.55 | 113.5 | 722.00 | 23.80 | 4.12 | 20.20 |
| Benthiocarb | 2.0 | 7 | 12.44<br>(154.33) | 19.64 | 6.82 | 16.71 | 87.70 | 308.00 | 16.66 | 3.07 | 14.90 |
| Pendimethalin | 1.0 | 7 | 11.55<br>(133.00) | 14.26 | 6.02 | 15.96 | 90.60 | 390.00 | 18.12 | 3.26 | 16.03 |
| Fluazifop-p-butyl | 0.25 | 20 | 11.81<br>(139.00) | 15.75 | 6.71 | 17.49 | 88.20 | 362.00 | 18.52 | 3.18 | 15.52 |
| Sethoxydim | 0.25 | 20 | 13.02<br>(169.00) | 22.09 | 7.17 | 19.35 | 86.20 | 311.00 | 16.37 | 3.10 | 15.08 |
| Benthocarb f.b.<br>Sethoxydim | 2.0 f.b.<br>0.25 | 7 f.b.<br>20 | 9.84<br>(96.33) | 7.12 | 3.77 | 12.85 | 102.10 | 470.00 | 21.45 | 3.57 | 17.56 |
| Benthocarb f.b.<br>Sethoxyolim | 2.0 f.b.<br>0.25 | 7 f.b.<br>20 | 9.97<br>(99.00) | 5.43 | 3.35 | 12.60 | 101.35 | 525.00 | 20.79 | 3.86 | 17.56 |
| Pendimethalin f.b.<br>Fluazifop-p-butyl | 1.0 f.b.<br>0.25 | 7 f.b.<br>20 | 8.33<br>(69.00) | 3.80 | 2.12 | 9.76 | 108.80 | 680.00 | 22.35 | 3.91 | 19.14 |
| Pendimethalin f.b.<br>Sethoxydim | 1.0 f.b.<br>0.25 | 7 f.b.<br>20 | 8.92<br>(79.00) | 3.87 | 2.50 | 11.36 | 102.20 | 570.00 | 21.93 | 3.78 | 17.98 |
| CD (P = 0.05) | | | 1.86 | 4.31 | 2.05 | 6.68 | 14.56 | 183.50 | 3.69 | 0.24 | 1.21 |

N.B. : The data transformed to $\sqrt{x+0.5}$ incase of weed dry matter. The original values are given in parenthesis; f.b. : followed by ; DAS : days after sowing.

uptake by weeds and crop (Table 1). Concentration of N,P and K did not show much variation under different treatments so the uptake of nutrients by weeds and crops under different treatments were related to the amount of dry matter production. Among the herbicide treatments, pre emergence application of pendimethalin 1.0 Kgha$^{-1}$ f.b. sequential application of fluazifop-p-butyl 0.25 Kgha$^{-1}$ had minimum depletion of N,P and K by weeds and maximum uptake by blackgram and was comparable with the treatment hand weeding twice at 20 and 40 DAS, which had the lowest nutrient depletion by weeds and the highest uptake by crop among all the treatments. This treatment is also on par with rest of the sequential treatments but significantly superior over the alone application of either pre or post emergence herbicides (except for potassium uptake in weeds alone with pendimethalin application). The minimum nutrient depletion by weeds in these treatments was owing to minimum weed dry matter produced as a result of effective weed control. So more nutrients could be available to the crop which resulted in higher uptake by blackgram.

The minimum uptake of these nutrients by crop was observed in unweeded check. It can be attributed due to lower crop dry matter production and low availability of these nutrients to crop as major amount of these nutrients were depleted by weeds. This shows the importance of keeping the crop free from weeds to enable the crop to absorb more nutrients from the soil. From the data it can be inferred that pre-emergence application of pendimethalin 1.0 Kgha$^{-1}$ f.b. sequential application of fluazifop-p-butyl 0.25 Kgha$^{-1}$ at 20 DAS can keep an effective check on nutrient depletion by weeds compared to alone application of either pre or post emergence herbicides in rice fallow blackgram.

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(Received on 20-05-2002 and revised on 06-08-2003)

The Andhra Agric. J., 50 (3&4) : 363- 367, 2003

## Research Note

# Effect of Combination of Herbicides on Weed Growth and Grain Yield of Irrigated Maize (*Zea mays* L.)

**Key words :** Combinations, Weed growth,Irrigated Maize.

Maize is an important cereal in our country next to rice, wheat and sorghum. During early growth stages of crop, weeds offer severe competition for growth factors. The critical period for crop weed competition in maize was from 20 to 40 days after sowing (Varshney, 1991). The conventional methods of hand weeding is slow, labour consuming and impractical during adverse weather conditions and cumbersome as compared to chemical method which is timely, economical and more effective. Atrazine at the recommended dosage is persistent for more than six months while the addition of chloracetamides, reduce atrazine dosage and residue build up without any appreciable decrease in weed control efficiency. In the evolution of herbicide programme, herbicide combinations have been considered as the most effective method of weed management (Chittapur *et al.,* 1997). Pre plant incorporation of a mixture of fluchloralin @ 0.5 kg a.i. ha$^{-1}$ and metolachlor @ 0.75 kg ha$^{-1}$ along with one hand weeding at 40 days after sowing was found to be effective for weed control leading to higher yields (Ravindranatha Reddy *et al.,* 1995). Therefore the present study was undertaken to evaluate the different herbicides and their combinations in irrigated maize.

A field experiment was conducted in S.V. Agricultural College Farm, Tirupati Campus during the *rabi* 1997 - 98. The experimental soil had a sandy loam with pH 7.7, available N 130 kg ha$^{-1}$ (low), available $P_2O_5$ 29 kg ha$^{-1}$ (high) and $K_2O$ 175 kg ha$^{-1}$ (medium). The experiment was laid out in a Randomised Block Design with 14 treatments and replicated thrice. The treatments involved were : $T_1$ atrazine @ 2 kg a.i. ha$^{-1}$ as pre-emergence (PE), $T_2$ metolachlor @ 2 kg a.i. ha$^{-1}$ as PE, $T_3$ fluchloralin @ 1 kg a.i. ha$^{-1}$ as pre-plant incorporation (PPI), $T_4$ atrazine @ 1 kg a.i. ha$^{-1}$ + metolachlor @ 1 kg a.i. ha$^{-1}$ as PE, $T_5$ fluchloralin @ 0.5 kg a.i. ha$^{-1}$ + metolachlor @ 1 kg a.i. ha$^{-1}$ as PPI, $T_6$ fluchloralin @ 0.5 kg a.i ha$^{-1}$ + atrazine @ 1 kg a.i. ha$^{-1}$ as PPI, $T_7$ atrazine @ 2 kg a.i. ha$^{-1}$ as PE + 1 hand weeding (HW) at 40 days after sowing (DAS), $T_8$ metolachlor @ 2 kg a.i. ha$^{-1}$ as PE + 1 HW at 40 DAS, $T_9$ fluchloralin @ 1 kg a.i. ha$^{-1}$ as PPI + 1 HW at 40 DAS, $T_{10}$ atrazine @ 1 kg a.i. ha$^{-1}$ + metolachlor @ 1 kg a.i. ha$^{-1}$ as PE with HW at 40 DAS, $T_{11}$ fluchloralin @ 0.5 kg a.i. ha$^{-1}$ + metolachlor @ 1 kg a.i. ha$^{-1}$ as PPI with HW at 40 DAS, $T_{12}$ fluchloralin @ 0.5 kg a.i ha$^{-1}$ + atrazine @ 1 kg a.i ha$^{-1}$ as PPI with HW at 40 DAS, $T_{13}$ two HW twice at 25 and 40 DAS, $T_{14}$ unweeded control. Required volume of herbicides as per treatments mixed with water (700 l $ha^{-1}$) and sprayed uniformly using a knap sack sprayer fitted with flat fan nozzle as per the treatment. Maize hybrid DHM - 107 of about 88 days duration was sown by dibbling at a depth of 4-5 cm by adopting spacing of 60 x 25 cm and followed other recommended package of practices. Weed population and weed dry weight were recorded at 25, 50, 75 DAS and at harvest.

Fourteen weed species were observed in the experimental field which comprised of six grasses viz. *Echinochloa colonum* L. *Panicum repens* L. *Commelina benghalensis* L. *Cynodon dactylon* (L.) Pers, *Dactyloctenium aegyptium* (L.) Beauv and *Digitaria sanguinalis* (L.) Scop; seven broad leaved weeds viz., *Cleome viscosa* L, *Trianthema portulacastrum L, Boerhaavia diffusa L, Phyllanthus niruri L,Digera arvensis Forsk, Eclypta alba Hassk* and *Celosia argentea* L. The only sedge that dominated in the experimental field was *Cyperus rotundus* L followed by *Cleome viscosa* L and *Echinochloa colonum* L.

Weed population and weed dry weight were significantly lower in all the weed control treatments when compared with unweeded control at all the stages of crop growth except at 25 DAS where unweeded control was on par with two hand weedings (HW not imposed at that time). The highest weed population and dry weight was recorded with unweeded control followed by fluchloralin treated plots. These results were in confirmity with Singh and Ramprasad (1988). This might be due to poor control of *Cyperus rotundus* L and phytotoxicity of the fluchloralin on maize plants. Hartzler and Fowcett (1983) reported that 1 ppm of fluchloralin in pot culture experiment reduced the maize root weight by 61 per cent. PPI of fluchloralin @ 1 kg a.i $ha^{-1}$ and PPI of fluchloralin at 1.0 a.i $ha^{-1}$ + 1 HW at 40 DAS were significantly reduced the final plant population by 9 and 11 per cent respectively over unweeded control. The reduction in plant population of maize due to phytotoxicity of fluchloralin as PPI might have encouraged the weeds in vacant places. Thus lack of optimum maize plant population lead to lower grain yield and ranked next to the unweeded control.

Atrazine @ 1 kg a.i $ha^{-1}$ + metolachlor @ 1 kg a.i $ha^{-1}$ with 1 HW at 40 DAS recorded lowest weed density and weed dry weight followed by two hand weedings. This might be due to effective control of broad leaved weeds and some grasses with atrazines by inhibiting the photosystem - II and causes decrease in chloroplast protein (Chittapur *et al.*, 1997). Initial growth of *Cyperus rotundus* L. up to 40 DAS can be checked to an extent of 40 per cent with PE application of metolachlor @ 2 kg a.i. $ha^{-1}$ (Thakur *et al.*, 1993). The complementary effect of combination of these two herbicides supplemented with 1 HW at 40 DAS gave broad spectrum weed control. The PE application of atrazine and metolachlor at 50% reduced dose supplemented with 1 HW recorded lowest weed dry weight and ultimately gave 48 per cent higher grain yield over unweeded control followed by two hand weedings. These results are in agreement with the results of Mulder and Doll (1993).

Thus, the combination of atrazine @ 1 kg a.i. $ha^{-1}$ + metolachlor @ 1 kg a.i. $ha^{-1}$ with HW at 40 DAS was found to be effective and economic weed management practice for irrigated maize. However, hand weeding twice at 25 and 40 DAS can also be done whenever the labour availability is not a problem.

Table 1 : Effect of different weed control treatments on weed population, weed dry weight, plant population and grain yield of maize.

| Treatments | 25 DAS | 50 DAS | 75 DAS | At Harvest | 25 DAS | 50 DAS | 75 DAS | At Harvest | Final plant population (thousand ha$^{-1}$) | Green yield (kg ha$^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_1$ : Atrazine @ 2 kg a.i. ha$^{-1}$ as pre-emergence (PE) | 21.34<br>(4.62) | 32.66<br>(5.71) | 40.33<br>(6.34) | 46.66<br>(6.86) | 13.0 | 27.55 | 60.72 | 62.55 | 60.45 | 34.90 |
| $T_2$ : Metolachlor @ 2 kg a.i. ha$^{-1}$ as PE | 24.66<br>(4.95) | 35.33<br>(5.94) | 50.00<br>(7.06) | 58.66<br>(7.66) | 21.26 | 38.76 | 71.73 | 72.93 | 60.12 | 3338 |
| $T_3$ : fluchloralin @ 1 kg a.i. ha$^{-1}$ as pre - plant incorporation (PPI) | 47.0<br>(6.83) | 70.66<br>(8.39) | 88.33<br>(9.40) | 98.33<br>(9.91) | 42.73 | 81.49 | 137.0 | 141.43 | 54.90 | 2561 |
| $T_4$ : Atrazine @ 1 kg a.i. ha$^{-1}$ + Metolachlor @ 1 kg a.i. ha$^{-1}$ as PE | 16.34<br>(4.04) | 25.67<br>(5.06) | 34.66<br>(5.87) | 37.66<br>(6.13) | 13.80 | 23.80 | 54.70 | 56.70 | 60.30 | 3853 |
| $T_5$ : Fluchloralin @ 0.5 kg a.i. ha$^{-1}$ + Metolachlor @ 1 kg a.i. ha$^{-1}$ as PPI | 34.66<br>(5.91) | 63.00<br>(7.93) | 77.66<br>(8.81) | 84.33<br>(9.18) | 31.27 | 58.90 | 125.79 | 126.55 | 58.49 | 2593 |
| $T_6$ : Fluchloralin @ 0.5 kg a.i. ha$^{-1}$ + Atrazine @ 1 kg a.i. ha$^{-1}$ as PPI | 35.33<br>(5.93) | 54.33<br>(7.36) | 68.67<br>(8.30) | 74.66<br>(8.64) | 27.48 | 55.0 | 127.65 | 140.06 | 60.13 | 3179 |
| $T_7$ : Atrazine @ 2 kg a.i. ha$^{-1}$ as PE + 1 hand weeding (HW) at 40 days after sowing (DAS) | 20.0<br>(4.26) | 12.33<br>(3.51) | 25.0<br>(4.98) | 28.33<br>(5.31) | 13.66 | 10.63 | 31.56 | 32.33 | 60.10 | 3977 |
| $T_8$ : Metolachlor @ 2 kg a.i. ha$^{-1}$ as PE + 1 HW at 40 DAS | 24.33<br>(4.89) | 15.66<br>(3.95) | 29.33<br>(5.41) | 32.67<br>(5.70) | 20.59 | 12.77 | 34.26 | 36.09 | 60.11 | 3780 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $T_9$ : Fluchloralin @ 1 kg a.i ha$^{-1}$ as PPI + 1 HW at 40 DAS | 44.0<br>(6.63) | 26.0<br>(5.09) | 51.33<br>(7.16) | 56.53<br>(7.50) | 39.00 | 22.80 | 69.16 | 72.06 | 53.84 | 2630 |
| $T_{10}$ : Atrazine @ 1 kg a.i ha$^{-1}$ + Metolachlor @ 1 kg a.i ha$^{-1}$ as PE with HW at 40 DAS | 16.0<br>(3.99) | 8.67<br>(2.93) | 15.67<br>(7.55) | 63.66<br>(7.97) | 13.95 | 7.49 | 18.32 | 19.10 | 60.27 | 4392 |
| $T_{11}$ : Fluchloralin @ 0.5 kg a.i ha$^{-1}$ + Metolachlor @ 1 kg a.i ha$^{-1}$ as PPI with HW at 40 DAS | 36.0<br>(6.05) | 24.33<br>(4.93) | 57.0<br>(7.55) | 63.66<br>(7.97) | 28.73 | 21.60 | 87.53 | 91.64 | 58.17 | 3025 |
| $T_{12}$ : Fluchloralin @ 0.5 kg a.i ha$^{-1}$ + Atrazine @ 1 kg a.i ha$^{-1}$ as PPI with HW at 40 DAS | 35.0<br>(5.91) | 20.33<br>(4.50) | 42.66<br>(6.53) | 49.66<br>(7.04) | 25.43 | 20.49 | 80.09 | 82.06 | 60.10 | 3392 |
| $T_{13}$ : Two HW at 25 DAS and 40 DAS | 98.66<br>(9.93) | 8.00<br>(2.82) | 20.33<br>(4.50) | 26.66<br>(5.16) | 86.60 | 7.49 | 22.29 | 23.96 | 60.43 | 4199 |
| $T_{14}$ : Unweeded control | 98.33<br>(9.96) | 121.33<br>(11.01) | 133.00<br>(11.53) | 150.0<br>(12.25) | 88.19 | 132.22 | 227.0 | 243.25 | 60.45 | 2298 |
| SEM ± | 0.19 | 0.19 | 0.19 | 0.18 | 0.68 | 0.60 | 2.05 | 1.32 | 0.48 | 80 |
| CD (0.05) | 0.56 | 0.54 | 0.56 | 0.53 | 1.98 | 1.74 | 5.97 | 3.85 | 1.40 | 231.0 |

* Square root transformed values in parenthesis ($\sqrt{x + 0.5}$)

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(Received on 31-01-2000 and revised on 20-12-2002)

The Andhra Agric. J., 50 (3&4) : 368 - 370, 2003

## Research Note

# Performance of Newly Released Herbicides on Weed Management of Direct Seeded Rice

Direct seeding of pre-germinated seeds of rice on puddled soil is becoming popular as it is a better and cheaper technique to traditional system but crop weed competition in this system is more severe because the germinating rice seedlings are susceptible to competition from weeds. Losses in grain yield due to weed competition were estimated to be around 43 to 83% (Sharma and Gupta, 1992 and Moorthy, 1997). Since, hand weeding is expensive, laborious and time consuming, and the mechanical and cultural methods are not always possible due to scarcity and high cost of labour in the peak period of rice cultivation, the herbicides are more effective in controlling weeds, besides reducing the total energy required for rice production (Srinivasan *et al.*, 1993). Hence, the present investigation was carried out to study the relative efficacy of some herbicides for control of weeds in direct seeded low land rice under puddled conditions.

The field experiment was conducted at Agricultural Research Institute, Rajendranagar, Hyderabad during *kharif* season of 1998. The soil of the experimental site was sandy loam having pH 7.5, organic carbon 0.92%, medium in available N (226.0 kg ha$^{-1}$), available $P_2O_5$ (17.5 kg ha$^{-1}$) and $K_2O$ (245 kg ha$^{-1}$). The crop variety RNR-4044 was sown on 7th July and harvested on 23rd October, 1998. Rice seeds @ 70 kg ha$^{-1}$ were soaked in water for 24 hrs and allowed to sprout after keeping in gunny bag for 24 hrs in shade. Sprouted seeds were broadcasted uniformly on puddled field. A common fertiliser dose of 40 kg N, 50 kg $P_2O_5$ and 30 kg $K_2O$ ha$^{-1}$ was applied as basal and the remaining nitrogen (80 kg ha$^{-1}$) in two equal splits was uniformly applied at 30 days after sowing (DAS) and at panicle initiation stage. Ten weed control treatments were tested in randomised block design with three replications. The time of application of herbicides was followed as per the table 1. One treatment with two hand weedings was carried out at 30 and 60 DAS. One unweeded ckeck was also maintained for comparison. Weed density and dry weight was recorded at flowering stage of grassy weeds.

The major weed flora recorded in the experimental field consisted of *Cyperus rotundus L., Cyperus difformis L., Fimbistylis miliacia L., Cyperus iria L.* in sedges; *Sphaeranthus indicus L., Marrilca munuta L., Ludwugia actovalvis in broad* leaved weeds; *Echinochloa crussgalli L., Panicum repens L* and *Echinochloa colonum L* in grasses. Sedges predominated the weed flora in unweeded plot (Table 1) which accounted for 57.6% of the total weed flora followed by broad leaved weeds (32.2%) and grasses (10.2%).

Table : Effect of herbicides on rice emergence, weed dry matter, yield attributes and grain yield of direct seeded rice under puddled conditions.

| Treatment | Herbicide Dose (kg a.i / ha) | Time of appln. (DAS) | Rice emergence sq.m | Weed dry matter at 40 DAS (g. sq. $m^1$) Grasses | Sedges | BLW | Total | WCE (%) | Productive tillers sq.$m^1$ | Panicle weight (g) | Grain yield (t $ha^1$) | Straw yield (t $ha^1$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Butachlor + Safener 50 EC | 1.0 | 3 | 160.4 | 22 | 20 | 36 | 78 | 87.9 | 539 | 2.58 | 5.21 | 7.60 |
| Rice guard (*Anilophos + Ethoxysulfuron*) 22 SC | 0.250 + 0.010 | 10 | 156.1 | 86 | 8 | 8 | 102 | 84.2 | 425.5 | 2.20 | 4.67 | 6.73 |
| Rice guard (*Anilophos + Ethoxysulfuron*) 22 SC | 0.375 + 0.250 | 10 | 156.5 | 48 | 16 | 10 | 74 | 88.5 | 482.0 | 2.24 | 4.77 | 6.93 |
| Rice star (*Fenoxy prop. o-Ethyl*) 7.5 EC | 0.056 | 15 | 120.5 | 22 | 122 | 68 | 212 | 67.2 | 38.0 | 2.12 | 4.17 | 5.82 |
| Rice stare (*Fenoxy prop. o-Ethyl*) 7.5 EC | 0.075 | 15 | 143.0 | 26 | 178 | 110 | 314 | 51.4 | 37.0 | 2.10 | 4.00 | 5.41 |
| Aniloguard (*Anilophos + 2, 4 DEE*) 25 + 32 EC | 0.4+0.53 | 10 | 121.0 | 32 | 40 | 42 | 114 | 82.3 | 398 | 2.50 | 4.50 | 6.94 |
| Clincher 10 EC (*Cryhalotopbutyl*) | 0.06 | 10 | 98.0 | 46 | 176 | 128 | 350 | 45.8 | 316.0 | 2.32 | 4.50 | 5.92 |
| Clincher 10 EC (*Cryhalotopbutyl*) | 0.08 | 10 | 124.4 | 30 | 208 | 154 | 392 | 39.3 | 372 | 2.40 | 4.65 | 6.21 |
| Two hand weedings 30 & 60 DAS | 30 & 60 DAS | 30 & 60 | 162.0 | 18 | 372 | 8 | 44 | 93.2 | 515 | 2.45 | 5.00 | 7.78 |
| Unweeded control | | | 124.8 | 66 | | 208 | 646 | | 215 | 1.80 | 2.33 | 4.20 |
| SEm + | | | 14.0 | | | | 22 | | 25 | 0.26 | 0.26 | 0.31 |
| CD (P = 0.05) | | | 32.0 | | | | 55 | | 53 | NS | 0.45 | 0.74 |

BLW = Broad leaved weeds WCE = Weed control efficiency

All the weed control treatments significantly influenced the density and biomass of the weeds. Weed biomass in unweeded plot was higher than the weed control treatments. Application of butachlor + safener (1.0 kg ai $ha^{-1}$) or higher dose of rice guard (Anilophos + ethoxysulfuron @ 0.375 + 0.250 kg ai $ha^{-1}$) or Aniloguard (Anilphos + 2, 4 D-EE @ 0.4 + 0.53 kg ai $ha^{-1}$) recorded lower weed dry matter and found more or less at par with two hand weedings treatment. Weed biomass in unweeded check was higher (646 g $m^2$) than all the weed control treatments. Lowest weed dry matter and highest weed control efficiency was recorded by two hand weedings at 30 and 60 DAS and it was statistically on par with butachlor + safener (1.0 kg ai $ha^{-1}$) and Riceguard @ 0.25 + 0.1 and 0.375 + 0.25 concentrations. Whereas application of clincher @ 0.06 and 0.08 kg ai $ha^{-1}$ recorded higher weed dry matter and lowest weed control efficiency which were found to be ineffective in controlling weeds as compared to other herbicide treatments.

The data on rice emergence sq. $m^1$ indicated nil or low toxic effect on germinating rice seedlings by weed control treatments. Aniloguard (Anilophos + 2, 4 DEE) showed toxic symptoms on emerging rice seedlings (121.0 sq $m^1$) at early stage, but at later stage of crop growth, controlled weed growth effectively and resulted in higher grain and straw yields next to butachlor + safener and riceguard.

Grain and straw yield was highest with the application of butachlor + safener @ 1.0 kg ai $ha^1$ and it was statistically on par with 2 hand weedings at 30 and 60 DAS or rice guard @ 0.375 + 0.25 kg ai $ha^1$. This could be attributed mainly to higher number of panicles sq. $m^1$ and weed control efficiency (Table 1) in these treatments. Uncontrolled weed growth in unweeded control treatment drastically reduced the grain yield by 53.3% and recorded the lowest grain yield. Moorthy (1997) reported similar results and observed 18 to 50% of yield reduction due to weeds in direct sown rice under puddled conditions. Severe infestation of weeds in rice field leads to higher competition for space, light and nutrients and thus resulting reduced tillering and decreased crop yield (Bhol and Singh, 1987).

Hence, it can be concluded that butachlor + Safener @ 1.0 kg ai $ha^{-1}$ at 3 days after sowing or rice guard (Aniolphos + Ethoxysulfuron) @ 0.375 + 0.25 kg ai $ha^{-1}$ at 10 days after sowing can be recommended for control of weeds in direct seeded puddled conditions.

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(Received on 07-09-2000 and revised on 06-08-2003)

The Andhra Agric. J., 50 (3&4) : 371 - 372, 2003

## Research Note

# Correlations in $F_2$ and $F_3$ Generations of Groundnut (*Arachis hypogaea* L.)

**Key words :** Correlations, $F_2$ and $F_3$ Generations.

Associations between external plant characters and groundnut pods formed underground (yield) and in proper selection of plants prior to harvest in groundnut. The experimental material consisting of 21 $F_2$ populations and their corresponding $F_3$ populations were studied during post rainy season, 1995 and rainy season, 1996, respectively in three replicate randomized block design with experimental plots consisting of three rows of 4m lengths at S.V. Agricultural College Wetland Farm, Tirupati. Observations were recorded on twenty plants in each replication of each $F_2$ / $F_3$ population for specific leaf area, shoot biomass, root dry mass, harvest index, mature pod number per plant and kernel yield. Correlation coefficients at genotypic and phenotypic levels were worked out as per Johnson *et al.* (1955).

Analysis of variance indicated highly significant differences among crosses for all the characters. Correlation coefficients (at genotypic and phenotypic level) between pairs of characters in $F_2$ and $F_3$ generation of groundnut are presented in Table 1. A perusal of magnitude of correlation coefficients indicated that genotypic correlations in general, were higher than the corresponding phenotypic correlations. This reveals the modified effect of environment on character association at genetic level. In the present study, highly significant and positive phenotypic correlations were observed between kernel yield and specific leaf area, harvest index and mature pod number per plant as also reported by Manoharan *et al.* (1990). Anuradha (1995) reported a non-significant correlation between yield and specific leaf area in 30 genotypes of groundnut where as Singh *et al.* (1985) suggested specific leaf area to aid in indirect selection for grain yield in field grown soybeans.

Shoot biomass and root dry mass exhibited significant negative phenotypic association with kernel yield in $F_2$ generation. These attributes exhibited a strong positive association with each other and a significant negative association with harvest index in $F_2$ and $F_3$ generations. Apart from kernel yield, shoot biomass also had significant negative association with mature pod number per plant in $F_2$ and $F_3$ generations. However, root dry mass exhibited non-significant negative phenotypic association with mature pod number per plant and kernel yield in $F_3$. Such changes in character associations from generation to generation are possible because of break down and formation of new linkage groups, reduction in dominance from $F_2$ and $F_3$ and also by method of sampling. Ketring (1984) and Huang and Ketring (1987) reported positive association between shoot growth and root growth characteristics. However, Bhan (1973) and Gupta *et al.* (1994)

reported significant linear associations between rooting traits and groundnut pod yield. Specific leaf area exhibited significant positive phenotypic association with shoot biomass in $F_3$. Mature pod number per plant was also found to be positively associated with harvest index and specific leaf area. Therefore the study indicated that specific leaf area, harvest index and mature pod number per plant may aid in selection of desirable plants for improvement of kernel yield in groundnut.

Table 1 : Phenotypic (P) and genotypic (G) correlation coefficients of groundnut in $F_2$ and $F_3$ generations.

| Character | | Shoot biomass | | Root dry mass | | Harvest index | | Mature pod number | | Kernel yield | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $F_2$ | $F_3$ | $F_2$ | $F_3$ | $F_2$ | $F_3$ | $F_2$ | $F_3$ | $F_2$ | $F_3$ |
| Specific leaf area | P | -0.138 | 0.253* | -0.124 | 0.131 | 0.248 | -0.024 | 0.389** | 0.325** | 0.453** | 0.300* |
| | G | -0.315 | 0.348 | -0.228 | 0.371 | 0.281 | -0.055 | 0.521 | 0.511 | 0.626 | 0.394 |
| Shoot biomass | P | | | 0.761** | 0.763** | -0.911** | -0.843** | -0.350** | -0.284* | -0.341** | -0.307* |
| | G | | | 0.930 | 0.909 | -1.003 | -0.916 | -0.643 | -0.605 | -0.850 | -0.524 |
| Root dry mass | P | | | | | -0.749** | -0.554** | -0.248 | -0.080 | -0.374** | -0.115 |
| | G | | | | | -1.017 | -0.757 | -0.850 | -0.377 | -0.890 | -0.288 |
| Harvest index | P | | | | | | | 0.517** | 0.678** | 0.611** | 0.705** |
| | G | | | | | | | 0.689 | 0.874 | 0.817 | 0.796 |
| Mature pod number | P | | | | | | | | | 0.593** | 0.831** |
| | G | | | | | | | | | 1.017 | 0.963 |

* Significant as $P \leq 0.05$

** Significant at $P \leq 0.01$

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(Received on 26-04-2000 and revised on 04-07-2003)

The Andhra Agric. J., 50 (3&4) : 373 - 374, 2003

## Research Note

# Biochemical changes Induced in The Total Body Constituents of *Spodoptera litura* (Fab.) by The Parasitoid *Peribaea orbata* (Wied.)

**Key words :** *Spodoptera litura, Peribaea orbata,* Biochemical changes.

*Spodoptera litura* (Fab.,), a polyphagous insect pest of many important crops (Singh and Jalali, 1997), is parasitized in its larval stage by *Peribaea orbata* (Wied.). These tachinid parasitoids lodge in the haemocoel of host and they ingest the bulk of host tissues and there by kill the host. The studies were made to assess the biochemical changes occur in all body tissues of *S. litura* due to parasitization.

For studying different parameters, laboratory reared unparasitized and experimentally parasitized V instar larvae of *S. litura* were used. After the emergence of parasitoids, haemolymph was collected from the host and an extract of total body tissues was prepared. The methods used for the estimation of different parameters are : dry weight, total proteins (Biuret method), glycogen (Hassid and Abraham, 1957), total lipids (Folch *et al.*, 1957), inorganic phosphate (Fiske and Subbarow method, Varley, 1976) and alkaline and acid phosphatase activity (4-amino antipyrine method, Varley, 1976).

Results (Table 1) indicated an increase of dry weight, inorganic phosphate, acid phosphatase activity and decrease in proteins, glycogen, lipids and alkaline phosphatase activity.

Table 1 : Biochemical changes induced in the body constituents of *S. litura* by the parasitoid *P. orbata*.

| S.No. | Parameter | No. of Samples | Un-parasitized | Parasitized | t-value |
|---|---|---|---|---|---|
| 1. | % Dry weight (mg.) | 5 | 9.99 ± 0.01 | 12.05 ± 0.1 | 166.59* |
| 2. | Total proteins (mg/gm tissue) | 6 | 61.67 ± 1.61 | 50.33 ± 1.55 | 13.18* |
| 3. | Glycogen (mg/gm tissue) | 3 | 6.22 ± 00.14 | 4.29 ± 0.1 | 7.41* |
| 4. | Total lipids (mg/gm tissue) | 3 | 54.47 ± 3.69 | 59.08 ± 0.99 | 2.05 |
| 5. | Inorganic phosphate (mg/gm tissue) | 6 | 0.43 ± 0.08 | 0.71 ± 0.25 | 5.53* |
| 6. | Alkaline phosphatase activity (Bodansky units / gm tissue) | 3 | 0.45 ± 0.01 | 0.08 ± 0.01 | 0.35* |
| 7. | Acid phsphatase activity (Bodansky units / gm tissue) | 3 | 0.18 ± 0.01 | 0.23 ± 0.03 | 0.22* |

* Significant at P = 0.05

Iwantsch and Smilowitz (1975) observed increased dry weight in the larvae of *Trichoplusia ni* (Hubner) parasitized by hymenopteran parasitoid, *Hyposoter exiguae* (Viereck). Increase of dry weight might be due to encapsulated bodies, exuviae and excreta of parasitoid inside the funnel.

Increased rate of metabolism and wound healing increased inorganic phosphate (Oser, 1976). Oser (1976) observed that histolysis produce an augument quantity of acid phosphatase due to high lysosomal activity. In S.*litura* tissue damaged due to parasitoid activity might have increased acid phosphatase.

Depletion of proteins in *Trichoplusia ni* (Hubner) due to parasitization by *Hyposoter exiguae* (Viereck) was reported by Iwantsch and Smilowitz (1975).

In S. *litura* moulting was not observed after parasitization. The parasitoid might have consumed the glycogen and lipids and used for their moulting and development. Defective moulting was reported earlier due to decreased lipids (House, 1963) and sugar (Oser, 1976). Decrease of sugar transport in the body ultimately decreased alkaline phosphatase activity (Oser, 1976). In S. *litura* decrease of glycogen ultimately decreased its transport which inturn decreased alkaline phosphatase.

## ACKNOWLEDGEMENT

The author is highly thankful to Dr. B. Nagalingam and Dr. V. Ramasubba Rao, Professors, Department of Entomology, Agricultural College, Bapatla for the help rendered by them.

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(Received on 22-04-2003 and revised on 23-08-2003)

The Andhra Agric. J., 50 (3&4) : 375 - 376, 2003

## Research Note

# Persistence of Selective Pesticides Against *Raphidopalpa foveicollis* *

**Key words :** Persistence, Pesticides.

The red pumpkin beetle *Raphidopalpa foveicollis* Lucas is a serious and destructive pest of the cucurbits in the early stages of plant growth, at times resulting in complete death of seedlings. Many researchers reported the efficacy of the insecticides against RPB, R. *foveicollis* (Khan and Khattak, 1992) and Thomas and Jocob (1994). But only few reports are there regarding the persistence of these pesticides against RPB, R. *foveicollis* (Thapa and Neupane, 1992). So the present investigation was oriented towards the persistance of the selective persticides against RPB, R. *foveicollis.*

A field trail was conducted during the December 1999 to May 2000 to evaluate the persistence of eight different pesticides against RPB, *Raphidopalpa foveicollis* after two consecutive sprayings. Pretreatment population was recorded from five selected plants of each plot. Post - treatment population was recorded on seventh, eleventh, fifteenth, nineteenth, twenty third and twenty seventh day after spraying and resurgence ratio was calculated by using a formula given by Pasupathy and Venugopal (1986).

$$\text{Resurgence ratio} = \frac{\text{Population in treated plot}}{\text{Population in control plot}}$$

Results of this trial revealed that imidacloprid posses longer persistence than the other chemicals. It possessed the persistence upto 19th day and was followed by profenophos and BPMC which posses the persistence upto 15th day. The effect of azadirachtin copperoxy chloride and bittergourd leaf extract was seen upto eleventh day. The commonly using fungicides on cucurbits i.e mancozeb and carbendazim showed persistence only for seven days. However, none of the pesticides showed the resurgence of red pumpkin beetle even after four weeks of application (Table 1).

Table 1 : Persistence of pesticide sprays against red pumpkin beetle *R. foveicollis* (after two consecutive applications)

| Treatment | Concentration percentage | per count | Adult beetle population after Days: 7 | | 11 | | 15 | | 19 | | 23 | | 27 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mean | RR | Mean | RR | Mean | RR | Mean | RR | Mean | RR | Mean | RR |
| Imidacloprid | 0.1 | 15 | 3 | 0.18 | 4.7 | 0.23 | 9.5 | 0.39 | 14.0 | 0.56 | 16.0 | 0.57 | 19.0 | 0.63 |
| Profenophos | 0.1 | 14.5 | 7.5 | 0.46 | 9.3 | 0.45 | 12.3 | 0.52 | 15.67 | 0.62 | 23.0 | 0.82 | 24.0 | 0.8 |
| Neemazal | 0.05 | 15.5 | 8.5 | 0.53 | 13.3 | 0.65 | 19.3 | 0.81 | 22.0 | 0.88 | 24.0 | 0.86 | 29.0 | 0.97 |
| Carbendazim | 0.05 | 13.5 | 10 | 0.61 | 14.3 | 0.69 | 17.3 | 0.73 | 21.0 | 0.84 | 240 | 0.86 | 29.0 | 0.97 |
| Mancozeb | 0.05 | 16.5 | 7.5 | 0.46 | 16.0 | 0.76 | 18.2 | 0.76 | 19.0 | 0.76 | 27.0 | 0.96 | 28.0 | 0.93 |
| Copperoxychloride | 0.1 | 10.0 | 7.8 | 0.48 | 12.3 | 0.60 | 12.7 | 0.53 | 16.0 | 0.64 | 22.0 | 0.79 | 25.0 | 0.83 |
| Bitter gourd leaf extract | 5.0 | 14.0 | 8.2 | 0.5 | 11.0 | 0.53 | 14.8 | 0.62 | 19.0 | 0.76 | 22.0 | 0.79 | 24.0 | 0.8 |
| BPMC | 0.1 | 16.0 | 6.5 | 0.3 | 9.0 | 0.43 | 10.8 | 0.45 | 18.0 | 0.72 | 20.0 | 0.74 | 25.0 | 0.83 |
| Control | | 17.0 | 16.5 | | 20.6 | | 24.0 | | 25 | | 28.0 | | 30.0 | |
| SEm ± | | | 1.44 | | 1.56 | | 2.48 | | 2.44 | | 2.29 | | 2.00 | |
| CD ( P = 0.05) | | | 2.03 | | 2.21 | | 3.5 | | 3.45 | | 3.24 | | 2.83 | |

RR - resurgence ratio

Mean : Mean adult population per plant

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(Received on 13-11-2000 and revised on 24-01-2004)

The Andhra Agric. J., 50 (3&4) : 377 - 380, 2003

## Research Note

# Chlorophyll Mutants in Okra (*Abelmoschus esculentus* L. Moench) Induced by Chemical Mutagens

**Key words :** Chlorophyll Mutants, Chemical mutagens, Okra

Many reports are available on induced chlorophyll mutations in various pulse crops. Konzak *et al.* (1965) proposed the concept of mutagenic effectiveness and efficiency. In the present experiment Okra, an important vegetable was taken to study the effect of chemical mutagens on chlorophyll mutations.

Three Okra varieties, **Haritha (LHS-1), Parbhani Kranti and Punjab Padmini** formed the material for study. Diethyl sulphate (dES) and Ethyl Methane sulphate (EMS) were used as the chemical mutagens. After mutagenic treatments $M_1$ generation was raised. Ten $M_1$ plants in each treatment and in control were advanced to $M_2$ generation. The $M_2$ seedling progenies were examined from the date of sowing to 20 days for chlorophyll mutants. The effectiveness and efficiency of mutagens in inducing chlorophyll mutants were estimated.

### Chlorophyll Mutation

The percentage of chlorophyll mutants was studied and presented in Table 1. The rate of chlorophyll mutations in $M_2$ seedling basis for the chemical mutagens EMS and dES ranged from 2.72 to 22.9 in the variety Haritha, from 4.06 to 12.5 in Parbhani Kranti and 2.0 to 13.8 in Punjab Padmini.

### Spectrum of chlorophyll mutants

The chlorophyll mutants observed in the $M_2$ generation included *Xantha, Viridis, chlorina, xantha viridis* and Maculata types. The observations from Table 1 suggest that EMS induced a wider spectrum of mutations in Okra varieties under study followed by dES. *Xantha* occured only in EMS treatments and the proportion of *chlorina* was higher than *viridis* and other types of mutations in EMS treatments, while in dES treatments *viridis* occured in a greater proposition than the other types at biologically comparable doses. Westergaard (1960) found that alkylating chemicals induced a higher proportion of *viridis* compared to albina. Albina was totally absent in all the treatments, whereas *xantha* was found only in EMS treatments. Maculata types were encountered in all the treatments but were more with dES at biologically comparable doses. The results were in consonance with those reported by several workers like, Singh *et al.* (1980) in pearl millet, Rao (1983) in bhendi, Pampapathy (1986) in brinjal and Reddy (1988) in cluster bean indicating EMS induced broader spectrum of chlorophyll mutations. Swaminathan *et al.* (1962) proposed that the frequency of a particular type of chlorophyll mutation is due to the

Table 1 : Effect of chlorophyll mutation percentage and different types of chlorophyll mutants in $M_2$ generation.

| | Chlorophyll mutation in $M_2$ seedlings | | | | Relative percentage of chlorophyll mutants | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Treatment dose (%) | No. studied | No segg-regating | Percentage | Total number of chlorophyll mutant seedlings | xantha | viridis | chlorina | xantha | Maculata viridis |
| Haritha | | | | | | | | | |
| EMS | | | | | | | | | |
| 0.2 | 680 | 14 | 5.00 | 14 | 0.14 | 0.88 | 1.91 | 1.18 | 0.88 |
| 0.35 | 240 | 19 | 22.9 | 19 | 0.42 | 4.58 | 8.33 | 5.42 | 4.17 |
| 0.5 | 320 | 12 | 8.125 | 12 | 0.94 | 0.94 | 3.13 | 2.19 | 0.94 |
| dES | | | | | | | | | |
| 0.025 | 640 | 9 | 2.81 | 9 | - | 1.56 | 0.63 | 1.09 | 0.94 |
| 0.075 | 480 | 12 | 6.04 | 12 | - | 2.08 | 1.67 | 1.89 | 1.89 |
| 0.125 | 440 | 7 | 2.72 | 7 | - | 3.40 | 1.36 | 1.14 | 1.59 |
| Control | 660 | - | - | - | - | - | - | - | - |
| Parbhani Kranti | | | | | | | | | |
| EMS | | | | | | | | | |
| 0.2 | 540 | 12 | 5 | 12 | - | 0.74 | 1.67 | 0.93 | 1.67 |
| 0.35 | 440 | 20 | 12.5 | 20 | 0.45 | 2.05 | 4.32 | 2.05 | 3.64 |
| 0.5 | 520 | 10 | 6.34 | 10 | 0.58 | 1.54 | 2.12 | 1.54 | 0.58 |
| dES | | | | | | | | | |
| 0.025 | 320 | 8 | 4.06 | 8 | - | 1.56 | 1.25 | 0.31 | 0.94 |
| 0.075 | 320 | 11 | 7.81 | 11 | - | 3.13 | 1.88 | 0.64 | 1.56 |
| 0.125 | 340 | 16 | 5.00 | 6 | - | 1.18 | 1.47 | 0.88 | 1.18 |
| Control | 660 | - | - | - | - | - | - | - | - |
| Punjab Padmini | | | | | | | | | |
| EMS | | | | | | | | | |
| 0.2 | 320 | 19 | 6.25 | 19 | - | 0.625 | 4.06 | 0.625 | 0.94 |
| 0.35 | 420 | 21 | 13.80 | 21 | 0.24 | 2.38 | 5.7 | 3.81 | 1.67 |
| 0.5 | 320 | 10 | 3.43 | 10 | 0.625 | 0.31 | 1.9 | 0.625 | - |
| dES | | | | | | | | | |
| 0.025 | 440 | 8 | 7.27 | 8 | - | 3.41 | 0.91 | 0.91 | 2.05 |
| 0.075 | 240 | 15 | 7.5 | 15 | - | 2.08 | 2.5 | 0.91 | 1.25 |
| 0.125 | 300 | 5 | 2.0 | 5 | - | 0.33 | 0.67 | 0.67 | 0.33 |
| Control | 480 | - | - | - | - | - | - | - | - |

Table 2 : Mutagenic effectiveness and efficiency of chlorophyll mutations in Okra.

| Treatment | Effectiveness | Efficiency | | |
|---|---|---|---|---|
| (dose in %) | M/tc | M/L | M/I | M/S |
| Haritha | | | | |
| EMS | | | | |
| 0.2 | 5.00 | 0.28 | 1.03 | 0.19 |
| 0.35 | 13.09 | 0.96 | 4.05 | 0.47 |
| 0.5 | 0.19 | 1.11 | 0.14 | |
| dES | | | | |
| 0.025 | 22.48 | 0.11 | 0.31 | 0.17 |
| 0.075 | 16.12 | 0.17 | 0.56 | 0.12 |
| 0.125 | 0.05 | 0.15 | 0.04 | |
| Parbhani Kranti | | | | |
| EMS | | | | |
| 0.020 | 5.00 | 0.13 | 0.69 | 0.27 |
| 0.135 | 7.14 | 0.30 | 1.11 | 0.32 |
| 0.5 | 2.54 | 0.12 | 0.26 | 0.11 |
| dES | | | | |
| 0.025 | 32.48 | 0.67 | 3.20 | 0.06 |
| 0.075 | 20.83 | 0.49 | 1.07 | 0.11 |
| 0.125 | 8.00 | 0.10 | 0.23 | 0.09 |
| Punjab Padmini | | | | |
| EMS | | | | |
| 0.2 | 6.25 | 0.28 | 0.45 | 0.21 |
| 0.35 | 7.88 | 0.60 | 0.45 | 0.20 |
| 0.5 | 1.372 | 0.70 | 0.09 | 0.05 |
| dES | | | | |
| 0.025 | 58.16 | 0.29 | 0.23 | 0.37 |
| 0.075 | 20.0 | 0.29 | 0.22 | 0.14 |
| 0.125 | 3.2 | 0.04 | 0.04 | 0.03 |

M : Percentage of M2 plants seggregating for chlorophyll mutations.

T : Period of treatment with chemical mutagen in hours

C : Concentration of chemical mutagen in percentage

L : Percentage of Lethality

I : Percentage of injury

S : percentage of pollen sterility in M1 plants preferential action of EMS on genes controlling chlorophyll development.

### Effectiveness and Efficiency

The mutagenic effectiveness and efficiency were calculated and presented in Table 2. The mutagenic effectiveness which is related to the number of mutational events generally increased upto a certain dose and then decreased in all the varieties and EMS treatments. With dES in all the varieties the effectiveness linearly decreased with increase in concentration of mutagen. The mutagenic efficiency as measured by lethality (M/L), seedling injury (M/I) or sterility (M/S) was greater at lower to moderate concentrations than at higher concentrations. The reason for this seems to be related to the fact that lethality, injury or sterility increases with mutagen level at a faster rate than mutations (Konzak *et al.,* 1965). Similar results were obtained by Yadav (1992) in greengram and Goutham *et al.* (1992) in blackgram.

### Summary

The study on potency of both the chemical mutagens in inducing chlorophyll mutations as measured by frequency at biologically comparable doses, revealed that EMS had high potency than dES. The different types of chlorophyll mutations recovered after treatment with different mutagens include xantha, viridis, chlorina, *xantha viridis* and Maculata. Albina types were absent in all treatments. Xantha types were recorded in EMS treatments only.

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(Received on 21-01-2000 and revised on 10-08-2003)

The Andhra Agric. J., 50 (3&4) : 381 - 383, 2003

## Research Note

# Study on the Efficiency of Gamma Rays in Inducing Mutations in Water Melon, *Citrullus lanatus (Thunb)* Mansf

**Key words :** Gamma Rays, Water Melon, Mutations .

Water melon is widely cultivated crop grown for its sweet, juicy pulp of the ripe fruit which is eaten fresh throughout the tropics. Induced mutations by their very nature offer a simple alternative to conventional breeding methodologies. There is scope to improve it through mutation breeding as the crop improvement through selection in terms of yield and fruit number is rather slow due to the quantitative nature of the traits which are subjected to genotype and environment interactions. Productive and systematic mutational studies have not yet been undertaken in watermelon and therefore, the present study was undertaken to study the effects of various doses of gamma rays in inducing desirable changes in watermelon.

The present study was conducted at Agricultural College Nutrition Garden, Agricultural college, Bapatla during spring summer 2000. The experimental material consisted of cv. Arka Manik of watermelon obtained from Indo-American Hybrid Seeds Company, Bangalore.

Parentage : IIHR - 21 x Crimson Sweet.

The facility of gamma cell $^{60}$ Co source located at Nuclear Agriculture And Biotechnology Division, Bhabha Atomic Research Centre, Trombay, Mumbai was made use of healthy well filled and dry seeds of uniform size were packed in butter paper covers and exposed to gamma rays. The seeds were subjected to 5 Kr, 10 Kr and 15 Kr. Seeds were soaked in distilled water for 6 hours prior to sowing. Plant protection, irrigation and intercultural operations were carried out as per the requirements of the crop uniformly.

The study revealed that 15Kr gamma ray treatment was found to be superior over all treatments in terms of quantitative characters like fruit length, fruit weight, number of fruits per vine and yield per vine. A perusal of the data (Table 1) shows that the seedling injury, vine length, number of branches per vine, per cent of female flowers per 100 male flowers, pollen fertiity, seed fertility, fruit length, fruit weight, number of fruits per vine and yield per vine ranges from 16.67% - 61.11%, 300.11 - 317.6, 7.89 - 11, 6.5 - 7.6, 48.08 - 92.99, 54.77 - 85.86, 17.36 - 19.43, 2.77 - 3.39, 1.78 - 3.44 and 5.19 - 11.12, respectively. The increase in seedling injury with increase in dose of gamma rays except 5Kr may be attributed to the inhibiting effects and toxicity of mutagens or due to damage to auxin system. Similar results were obtained by Chezhiyan

Table 1 : Effect of gamma ray irradiation on watermelon

| Treatment | Seedling injury | Vine length at maturity (cm) | Mean No. of branches per vine | Per cent of female flowers per 100 male flowers | Pollen fertility | Seed fertility | Fruit length (cm) | Fruit weight (Kg) | Number of fruits per vine | Yield per vine (Kg) |
|---|---|---|---|---|---|---|---|---|---|---|
| Control | 0.00 | 317.60 | 11.0 | 6.9 | 74.51 | 85.86 | 17.36 | 2.77 | 1.78 | 5.19 |
| 5 Kr | 61.11 | 310.00 | 7.89 | 6.5 | 48.08 | 54.77 | 17.94 | 3.13 | 2.33 | 8.03 |
| 10 Kr | 16.67 | 306.38 | 8.11 | 7.6 | 90.31 | 70.36 | 18.95 | 3.35 | 2.89 | 10.16 |
| 15 Kr | 22.22 | 300.11 | 9.04 | 7.0 | 92.99 | 78.94 | 19.43 | 3.59 | 3.44 | 11.12 |

*et al.* (1998) in Jasmine. Decrease in vine length was may be due to auxin destruction and changes in auxin and ascorbic acid content Gunkel and Sparrow (1954). The increase in number of female flowers per 100 male flowers may be attributed to increased levels of neutral auxins which are responsible for early induction of flowers Heslop - Harrison (1963). Similar results were obtained by Nath and Madan (1986) in Cucumber. The increase in pollen fertility over control was may be due to the lower doses of gamma rays adopted in the present study which failed to induce pollen sterility as they are in contrary to the findings of Yogesh Kumar and Mishra (1998). Decrease in seed fertility over control was may be due to mutant gene which acts as a foreign element and disturbs the genic harmony of the genome resulting in the inspecific reduction of seed fertility of mutants. This is confirmity with the findings of Gaul *et al.* (1966). The reason for increased number of fruits may be attributed to the increase in pollen fertility which was induced by mutagen in the present study or it may be due to transient modification or heritable mutation. The reason for increased yields was may be due to cumulative effect of all yield attributing traits. Many quantitative characters are controlled by polygenic systems. Under the influence of mutant genes these can be easily altered positively or negatively. Shifts of the genetically conditioned variability of these traits are common. Similar results were obtained by Garibyan *et al.* (1986) in melons and Li *et al.* (1995) in cucurbits.

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(Received on 27-06-2002 and revised on 06-12-2002)

The Andhra Agric. J., 50 (3&4) : 384 - 385, 2003

## Research Note

# Study on Yield and its Attributing Characters of Tuberose in Relation to N and $K_2O$ Levels

**Key words :** Attributing Characters, Tuberose.

In India tuberose (*Polianthes tuberose* L.), an important flower crop is grown extensively on poor and marginal soils. The yield of the crop which is a complex character is influenced significantly with the application of fertilizer. A positive correlation between the flower characters and yield was also reported by Mohanty (1999). Hence an experiment was laid with an objective to study the effect of different levels of nitrogen and potassium on flower characters and yield of the crop.

The experiment was conducted at Horticultural Research Station, Aswaraopet with four levels of nitrogen i.e. 0.75, 100 and 125 kgs / ha and four levels of potassium i.e. 0, 40, 60 and 80 kgs / ha in a sandy loam soil which is low in available nitrogen and potassium, medium in phosphorus using completely randomized design. Plant height, number of spikes / clump, spike length, number of flowers per plant and flower yield per plant were recorded and statistically analysed as reported by Pause and Sukhante (1985).

Perusal of the data in table -1 indicated that application of nitrogen @ 75 kgs / ha. and potassium @ 40 kgs/ ha. significantly increased the plant height, number of spikes per clump, spike length, number of flowers per plant and flowers yield over control. However, with further increase in the levels of nitrogen and potassium not much improvent was observed as their results were satistically on par with each other in these characters satistically except at $N_3K_3$ which recorded highest yield over few treatments. Similar response to the increasing levels of N and K were also reported by Parthiban *et al.* (1992) in tuberose.

Table 2 : Correlation coefficients between flower yield and other characters in tuberose.

| | Plant height | Number of spikes / clump | Spike length | Number of flowers / plant | Flower yield per plant |
|---|---|---|---|---|---|
| Plant height | 1.0000 | 0.9194** | 0.8393** | 0.9191** | 0.7102** |
| Number of spikes per clump | | 1.0000 | 0.8313** | 0.9672** | 0.7033** |
| Spike length | | | 1.0000 | 0.8242** | 0.7840** |
| Number of flowers per plant | | | | 1.0000 | 0.7536** |
| Flower yield / plant | | | | | |

Table 1 : Performance of different characters of tuberose on varying levels on N and $K_2O$

| Treatment | Plant height (cm) | Number of spikes / clump | Spike length (cm) | Number of flowers / plant | Flower yield per plant (g) |
|---|---|---|---|---|---|
| $N_0 K_0$ | 78.80 | 0.90 | 6.10 | 18.30 | 16.50 |
| $N_1 K_0$ | 94.40 | 4.10 | 22.00 | 86.40 | 81.80 |
| $N_2 K_0$ | 94.40 | 4.70 | 25.00 | 112.70 | 102.30 |
| $N_3 K_0$ | 99.70 | 5.10 | 25.30 | 124.60 | 122.20 |
| $N_0 K_1$ | 93.00 | 4.00 | 22.60 | 89.00 | 86.10 |
| $N_0 K_2$ | 94.20 | 4.50 | 23.50 | 95.50 | 95.70 |
| $N_0 K_3$ | 95.20 | 5.20 | 24.40 | 101.30 | 99.90 |
| $N_1 K_1$ | 95.40 | 5.40 | 25.10 | 104.70 | 101.0 |
| $N_1 K_2$ | 94.70 | 4.70 | 23.40 | 99.30 | 95.10 |
| $N_1 K_3$ | 95.00 | 4.90 | 24.40 | 103.90 | 97.30 |
| $N_2 K_1$ | 96.10 | 5.10 | 25.10 | 108.70 | 118.70 |
| $N_2 K_2$ | 99.40 | 5.40 | 24.20 | 115.50 | 115.10 |
| $N_2 K_3$ | 96.70 | 4.30 | 21.30 | 90.20 | 88.10 |
| $N_3 K_1$ | 96.40 | 5.40 | 22.00 | 112.50 | 124.50 |
| $N_3 K_2$ | 97.10 | 5.60 | 23.60 | 124.30 | 124.90 |
| $N_3 K_3$ | 98.30 | 6.40 | 24.30 | 145.20 | 140.70 |
| 'F' test | NS | * | * | * | NS |
| CD (0.05) | 9.59 | 1.43 | 3.62 | 40.08 | 42.55 |
| CV (%) | 6.06 | 18.14 | 9.27 | 23.56 | 25.44 |

$N_0$ : 0 kg N/ha $K_0$ : 0 kg $K_2O$/ha F(2,15) = 3.63 (5%)
$N_1$ : 75 kg N/ha $K_1$ : 40 kg $K_2O$/ha = 6.36 (1%)
$N_2$ : 100 kg N/ha $K_2$ : 60 kg $K_2O$/ha
$N_3$ : 125 kg N/ha $K_3$ : 80 kg $K_2O$/ha

Correlation coefficient (Table-2) revealed that all the characters (i.e) plant height, number of spikes per clump, spike length, number of flowers per plant correlated positively and significantly with flower yield indicating their close association Similar results were also reported by Mohanty (1999).

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(Received on 01-10-2002 and revised on 10-04-2003)

The Andhra Agric. J., 50 (3&4) : 386 - 387, 2003

## Research Note

# Studies on Physiological Maturity in Bengalgram (*Cicer arietinum* L.)

**Key words :** Physiological Maturity, Bengalgram.

Seed maturity and its harvesting are the major consideration in production of quality seed. Harvesting of seed at optimum stage of maturity has implication in recovery of quality seed. In greengram and redgram physiological maturity has attained at 25 and 45 - 49 DAA (Dharmalingam and Basu, 1990 and Khairb *et al.*, 1993). The present investigation was undertaken to study the rate of pod development and physiological maturity in bengalgram.

The experiment was conducted during *rabi* 1998 - 1999 at Regional Agricultural Research Station, Lam, Guntur. The experiment was laid out in randomised block design replicated thrice. The seed of Bengal gram var. ICCV-2 was sown in a plot size of 3m x 2.5m with a spacing of 30 cm x 10 cm. Approximately 1000 flowers were tagged in the morning hours. The day on which the buds tagged was taken as first day. A sample of randomly selected 10 pods from tagged flowers was taken for periodical observations on pod length and pod width. Were Separated pods into pedicel, pod wall and seed; kept in oven for drying at 80$^0$C upto constant weight. The dry seeds were germinated using BP method as per ISTA (Annonymous, 1985).

The results revealed that there was no significant difference between stages of pod development and pod length and width (Table 1). The rate of increase of pod length from the beginning to 41 to 45 DAA was very low. The pod attained maximum length at 29 - 35 DAA. The pod width was miximum at 0-7 DAA and thereafter the rate of increase was marginal. There was significant difference between dry matter accumulation in pedicel, pod wall and seed at different stages of pod development. Generally, the changes in dry matter production of different parts followed a sigmoid trend. The major part of increase in dry matter production of pedicel was between 8-14 and 15-21 DAA. The contribution of dry matter from podwall to fruit was higher as compared to pedicel and seed. Maximum dry matter accumulated in podwall at 36-40 DAA and thereafter it decreases. The contribution of dry matter from seed to fruit was highest from 8-14 DAA to 41-45 DAA compared to pedicel and podwall. Seed initiation occurred at 4 days after anthesis. The pod parts attained constant weight and physiological maturity (maximum dry matter accumulation) at 41 - 45 DAA. The per cent contribution of dry matter by pedicel, podwall and seed to the pod at 41 - 45 DAA was 4 : 8, 22.0, 73.2 respectively. Similar trends of dry matter accumulated in chilli fruit was reported by Rao and Rao (1990).

Table : Pod development and dry matter accumulation in Bengalgram.

| | | | Drymatter accumulation (mg) | | | |
|---|---|---|---|---|---|---|
| Days after anthesis | Pod length (cm) | Pod width (cm) | Pedicel | Podwall | Seed | Germination (%) |
| 0 -7 | 1.9 | 2.7 | 6 | 12 | 3 | - |
| 8 -14 | 2.2 | 3.3 | 10 | 33 | 53 | - |
| 15 -21 | 2.4 | 3.5 | 14 | 55 | 111 | 11.4<br>(19.7) |
| 22 -28 | 2.4 | 3.6 | 16 | 60 | 182 | 44.1<br>(41.6) |
| 29 - 35 | 2.5 | 3.8 | 15 | 65 | 219 | 80.0<br>(63.7) |
| 36 - 40 | 2.5 | 3.7 | 15 | 71 | 234 | 91.0<br>(72.6) |
| 41 - 45 | 2.5 | 3.7 | 15 | 71 | 235 | 91.0<br>(72.6) |
| CD at 5% | NS | NS | 4.2 | 9.6 | 14.6 | 7.1 |

Values in parenthesis are arcsine transformed values.

It is interesting to note that during early stages, the pod wall contributed more to the total pod development and it was seed in the latter stages. Translocation of dry matter into seeds was slow upto 0-7 DAA and reached peak values at 41-45 DAA. Later the dry matter accumulation in a seed showed a asymptotic trend. Such dynamic trends in dry matter production of podwall seed indicated that any gain seed weight may be at the cost of dry weight of podwall. Hence podwall act as source and seeds forms as a potential sink. From the changes observed in dry matter production of component parts it is observed that physiological maturity occured at 41-45 DAA. The percentage of germination was low upto 28 DAA and thereafter it gradually increased upto 40 DAA. Maximum germination per cent was recorded at 41-45 DAA. These results are in confirmity with the Bharud and Patil (1990) in bengalgram. The parameters, dry matter accumulation and germination potential suggest that the physiological maturity has attained 41-45 Days after anthesis. The complete loss of green colour of pod was found to be an useful indicator for judging the optimum physiological maturity in the field.

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(Received on 21-07-2000 and revised on 21-10-2003)

The Andhra Agric. J., 50 (3&4) : 388 - 390, 2003

## Research Note

# Strategies for Sustainable Tribal Agriculture Under WTO Regime - Case Studies in Visakha Agency

**Key words :** Sustainable, WTO Regimes.

A significant proportion (87.5%) of the tribal population is dependent on agriculture not only for their livelihood but also for survival and are just around the poverty line. In the present context of WTO ensuring food security and commercialization of agriculture are two basic issues of government policies in agrarian developing countries. There are also internal constraints, which would severely limit the capacity of tribal areas to increase their domestic producion to at least a minimum percentage of their requirements. Moreover there is a conflict between chemical intensive agriculture and the non-chemical sustainable technological innovations and subsidies. Besides these, the post harvest aspects and marketing are limiting factors for the sustainability of tribal agriculture. In this context Case studies were conducted to understand the implication of World trade agreements on tribal agriculture and render strategies for the subsistence farming under WTO regime.

The study was conducted in the agency area of Visakhapatnam district of HAT zone in Andhra Pradesh. To collect the requisite data, Two mandals viz., Chintapalle and Gudem Kotha Veedhi and four villages (two villages from each mandal) were selected purposively as they are not only accessible but also had the representative features of HAT zone. A pre tested schedule and PRA Techniques were adopted for collection of resource base, productivity constraints, marketing aspects, competetiveness and extent of sustainability of tribal agriculture. The data were collected during the years 2001 - 03.

The study revealed that in tribal areas a significant proportion (87.5%) of the population dependent on agriculture are below the poverty line and Woman force also more in tribal agriculture. Majority of farmers belong to the small and marginal category (76.30%) and holdings are small (0.67 to 2 ha) limiting any attempts to introduce mechanized farming. Tribal agriculture is mostly practiced on primitive lines as evidenced by shifting cultivation and productivity is low due to insufficient fertilization and use of anachronistic technologies. The total production varies substantially due to production constraints like poor irrigation facilities, low fertility and undulated topography. The agricultural produce of tribal area is evidently with less chemical residue, which is not due to awareness about the market requirements under WTO context but due to unconscious following of organic farming (60-65%) by tribal farmers and due to their low socio economic profile and ignorance. Organic farming, low pest and diseases, which are the prime requirements for getting quality produce in the WTO regime, are

Area, Production, Productivity and Market Aspects of Selected Crops in Tribal Areas of Visakhapatnam

| Sl.No. | Crop | Area (Ha) | Productivity t/ha | Total production (t) | Qty Marketed (t) | Qty for Domestic and Barter use (t) |
|---|---|---|---|---|---|---|
| 1. | Rice | 7168 | 1.850 | 13261 | 3200 | 10060 |
| 2. | Jowar | 254 | 0.7 | 178 | 7.5 | 170 |
| 3. | Maize | 3969 | 1.7 | 6747 | 3300 | 3447 |
| 4. | Ragi | 4313 | 1.1 | 3235 | 550 | 2685 |
| 5. | Sama | 4863 | 0.75 | 3647 | 75 | 3572 |
| 6. | Redgram | 493 | 1.6 | 491 | 60 | 431 |
| 7. | Niger | 3622 | 0.47 | 1702 | 675 | 1027 |
| 8. | Turmeric | 173 | 4.85 (Dry) | 839 | 550 | 289 |
| 9. | Ginger | 200 | 12 | 2400 | 1100 | 1300 |
| 10. | Rajh mash | 955 | 1.5 | 1432 | 560 | 872 |

the natural entities of the tribal areas. Only a small percentage (20-30%) of what is produced finds itself in the market, remaining produce is kept for their sustenance or for simple barter use. Middlemen activity finds place in the marketing of agricultural produce which is due to improper marketing facilities and lack of proper credit and low profile in cooperative movement among tribal farmers. The little progress and existence of tribal agriculture is evidently due to support and encouragement.

### Extension Strategies proposed

☆ Encouragement to be given to promote Organic farming : Steps to be taken to make the farmers to understand the practices and prospects and incentives to be given to the farmers practicing organic farming.

☆ Focus on group approach : Cooperative farming and marketing should be organized. Technology dissemination through farmer interested groups and self help groups and tribal leaders should be given due importance (Sarkar*et al.*, 2002).

☆ Capacity building of extension functionaries and farmer interest groups in terms of improved production, cost reduction technologies, post harvesting operation and storage required to withstand in the present scenario.

☆ Effective linkages between production system, marketing, Agro-processing, farmers groups, markets and private processors. Agro based industries should be encouraged.

☆ Market lead Agriculture and advice on product planning : Farmers need to know answers to questions like what to produce, when to produce, how much to produce, when and where to sell at what price and what form to sell.

☆ Utilization of Information technology for market information and market intelligence Involving educated tribal farmers access cyber extension services.

☆ Improvement in productivity of diversified farming system with regional specialization and sustainable management of natural resources. Farming systems like Agriculture - Apiculture, Agriculture - Sheep rearing, agriculture - dairy should be encouraged.

☆ Participatory mode of Watershed management and Soil and water conservation and wasteland management for sustainable agricultural productivity with out degradation of natural resources (Mishra, 2002)

☆ Tribal agricultural growth can be sustained and the food security objective can be realized through increased governmental support.

☆ As the women force is also high in tribal agriculture, gender concern need to be mainstreamed in agricultural Extension process and women empowerment is to be given priority. (Das, 2002)

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(Received on 07-11-2003 and revised on 31-01-2004)

The Andhra Agric. J., 50 (3&4) : 391 - 393, 2003

# Research Note

## Farmers Attitude Towards Recharging of Wells

**Key words :** Farmers Attitude, Rechargring of Wells.

Water resources are a precious national asset holding key position to the economy of the country. In our country with increase of population and other processes like urbanization and industrialization the water is generally proved to be an uncertain and limited source in arid and semi arid region. Groundwater is only source of this region for irrigation and other purposes. According to central groundwater Board, due to large-scale withdrawal of groundwater, water levels are declining at an alarming rate. This situation can be tackled by artificially recharging the groundwater using various recharge techniques. Among different recharge techniques, well recharging technique is found to be a easiest and most economical method. Keeping this in view a study entitled " Attitude of farmers towards well recharging" was undertaken with following objectives.

To know the level of attitude of farmers towards well recharging.

To ascertain the association of farmers' attitude towards well recharging with their selected characteristics.

To predict the extent of variation in farmers' attitude towards well recharging caused by their selected characteristics.

The study was conducted in Junagadh district of Gujarat state. A sample of 200 respondents representing ten villages from five talukas was drawn by using multistage random sampling technique.

The data were collected by personal interview of the farmers with the help of pre-tested structured schedule. Attitude of the farmers towards well recharging was measured with the help of five - point attitude scale developed by investigator (1999). The total score for an individual was calculated and summed up and grouped as (I) less favourable (II) favourable (III) highly favourable with the help of mean and standard deviation.

Keeping in view of the objectives, 12 independent variables were selected. The attitude of the farmers towards well recharging was considered as dependent variable. In order to ascertain the association between independent variable and dependent variable, the correlation coefficient was applied. Further the multiple regression was also worked out to trace the predictive abilities of independent variables on the dependent variable.

The data in (Table 1) clearly indicated that nearly one - thrid (65-50 per cent) of the

Table 1: Distribution of respondents according to their level of attitude towards well recharging.

| Sl. No. | Level of attitude | Number | Per cent |
|---|---|---|---|
| 1. | Less favourable (below 10.31 score) | 36 | 18.00 |
| 2. | Favourable (10.31 to 14.19 score) | 131 | 65.50 |
| 3. | Highly favourable (above 14.19 score) | 33 | 16.50 |
| | Total | 200 | 100.00 |
| | $\overline{X}$ = 12.25 | | S.D. 1.91 |

Table 2: Association between the level of attitude of the respondents towards well recharging and their selected characteristics.

| Sl. No. | Characteristics | 'r' Value |
|---|---|---|
| 1. | Age | -0.2351** |
| 2. | Education | 0.3220** |
| 3. | Size of land holding | 0.0171 |
| 4. | Annual income | 0.0886 |
| 5. | Social paraticipation | 0.4914** |
| 6. | Motivational sources | 0.5613** |
| 7. | Extension participation | 0.5350** |
| 8. | Innovation proneness | 0.4628** |
| 9. | Irrigation index | 0.6266** |
| 10. | Localite cosmopolite value orientation | 0.5434** |
| 11. | Risk orientation | 0.1026 |
| 12. | Knowledge about recharging practice | 0.2436** |

** = Significant at 0.01 level

respondents having favourable attitude was followed by nearly equal (18.00 per cent and 16.50 per cent) of the respondent having less and highly favourable attitudes towards well recharging, respectively. This finding was in line with the findings of Reddy (1987) and Rakholia (1996).

It can be seen from the Table - 2 that there was positive and significant association between the level of attitude of the respondents towards well recharging and their education, social participation, motivational sources, extension participation, innovation proneness, irrigation index, localite cosmopolite value orientation and nowledge. There was negative and significant association between the level of attitude of the respondents towards well recharging and age. Other variables like, size of land holding, annual income and risk orientation had shown non-significant association with the level of attitude towards well recharging.

Table - 3 clearly shows that the total contribution of nine independent variables was 67.46 per cent (R = 0.6746). The calculated 't' value were found highly significant at 0.01 level for five variables i.e. social participation, motivational sources, innovation proneness, irrigation index and knowledge, while only two variables i.e education and localite cosmopolite value orientation were significant at 0.05 level of probability.

Table 3 : Multiple regression analysis between level of attitude of the respondents and their independent variable.

| Sl.No. | Independent variable | Partial 'b' value | 't' value of partial 'b' df = 199 | Standard partial beta 'b' | Rank order | R² |
|---|---|---|---|---|---|---|
| 1. | Age | 0.0283 | 0.590 | 0.0314 | IX | |
| 2. | Education | 1.4028 | 2.041* | 0.1081 | VII | |
| 3. | Social participation | 0.9599 | 4.204** | 0.1948 | II | |
| 4. | Motivational sources | 3.0393 | 4.111** | 0.2032 | III | |
| 5. | Extension participation | 0.0751 | 1.656 | 0.0867 | VIII | 0.6746 |
| 6. | Innovation proneness | 1.6955 | 3.520** | 0.1650 | IV | |
| 7. | Irrigation index | 2.9295 | 6.022** | 0.3034 | I | |
| 8. | Localite cosmopolite value orientation | 0.4326 | 2.171* | 0.1136 | VI | |
| 9. | Knowledge about well recharging practice | 0.1559 | 3.616** | 0.1452 | V | |

* Significant at 0.05 level
** Significant at 0.01 level

The relative contribution of irrigation index, social participation, motivational sources, innovation proneness, knowledge, localite cosmopolite value orientation and education were in descending order and these seven variables were important in affecting the level of attitude of farmers towards well recharging.

## CONCLUSION

It is concluded that the size of land holding, annual income and risk orientation does not influence the level of attitude of the farmers towards well recharging, whereas age, education, social participation, motivational sources, extension participation, innovation proneness, irrigation index, localite cosmopolite value orientation and knowledge level about well recharging practice influences the level of attitude of farmers towards well recharging.

## IMPLICATION

Extension agencies should strive to raise the level of attitude of farmers towards well recharging by considering characteristics like irrigation index, social participation, motivational sources, innovation proneness, knowledge about well recharging practice, localite cosmopolite value orientation and education. For this there is an urgent need to organize effective training and demonstration programme at village level to motivate the farmers for adopting the well - recharging practice.

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(Received on 21-05-2002 and revised on 16-06-2003)

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Edited and Published by **Dr. P. ARJUNA RAO** for The Andhra Agricultural Union
and Printed by **Sri G. VEERAIAH** at **SREE LAKSHMI PRESS, BAPATLA** - 522 101 (AP)
(Released in June, 2004)